Product Engineering

APRIL 1953

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Five Dollars a Year

Electrolytic Tanks for Determining Vacuum Tube Characteristics

Contents Page 3

THE LEADERS LOOK TO THE LEADER

Kiekhaefer uses C/R Oil Seals

Slim, sleek, compact and powerful, Mercury outboard motors, made by the Kiekhaefer Corporation of Fond du Lac, Wisconsin, give true championship performance in each horsepower class. They're thoroughbreds in every sense of the word . . . dependable offspring of "thoroughbred" engineering!

Many fine points of design and engineering have combined to produce the exceptional reputation of Mercury outboards. Not the least of these is the consideration which Kiekhaefer engineers have given to the ever-present problem of lubricant retention and water exclusion. C/R "Perfect" oil seals have long been their choice to deliver dependable service through the lifetime of the motor.

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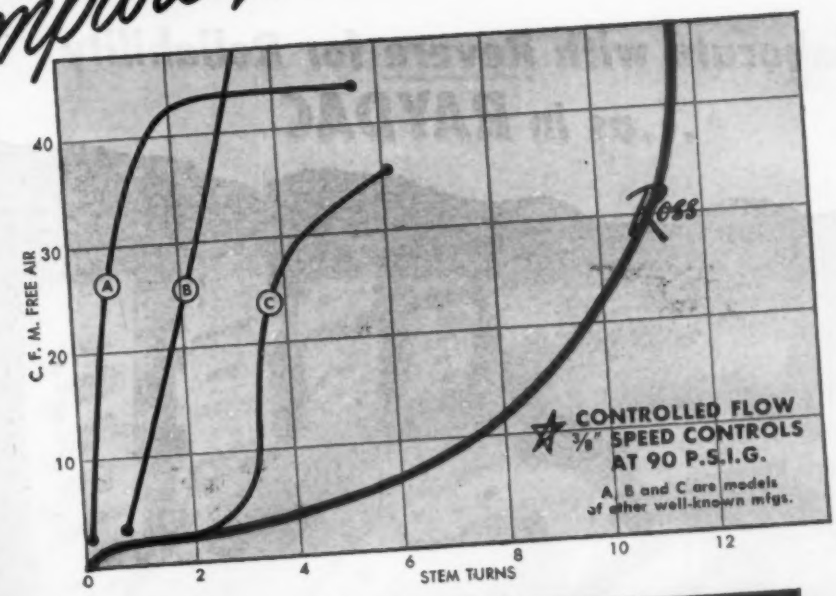

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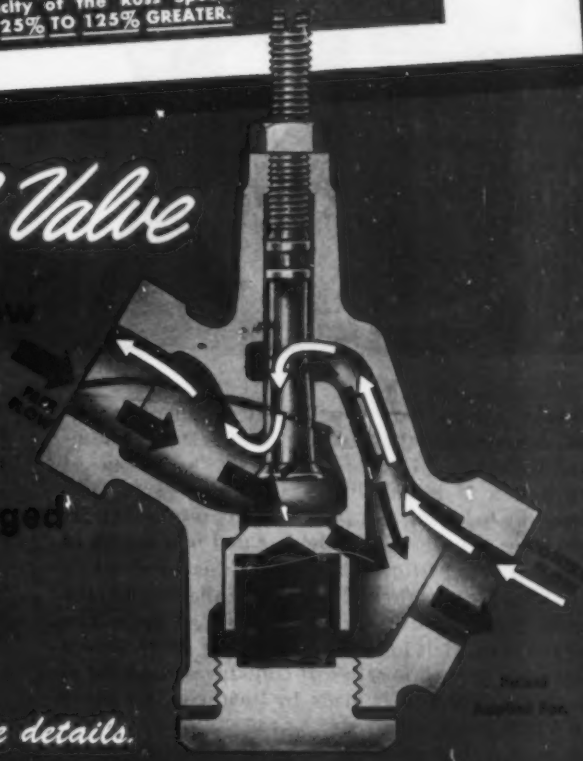

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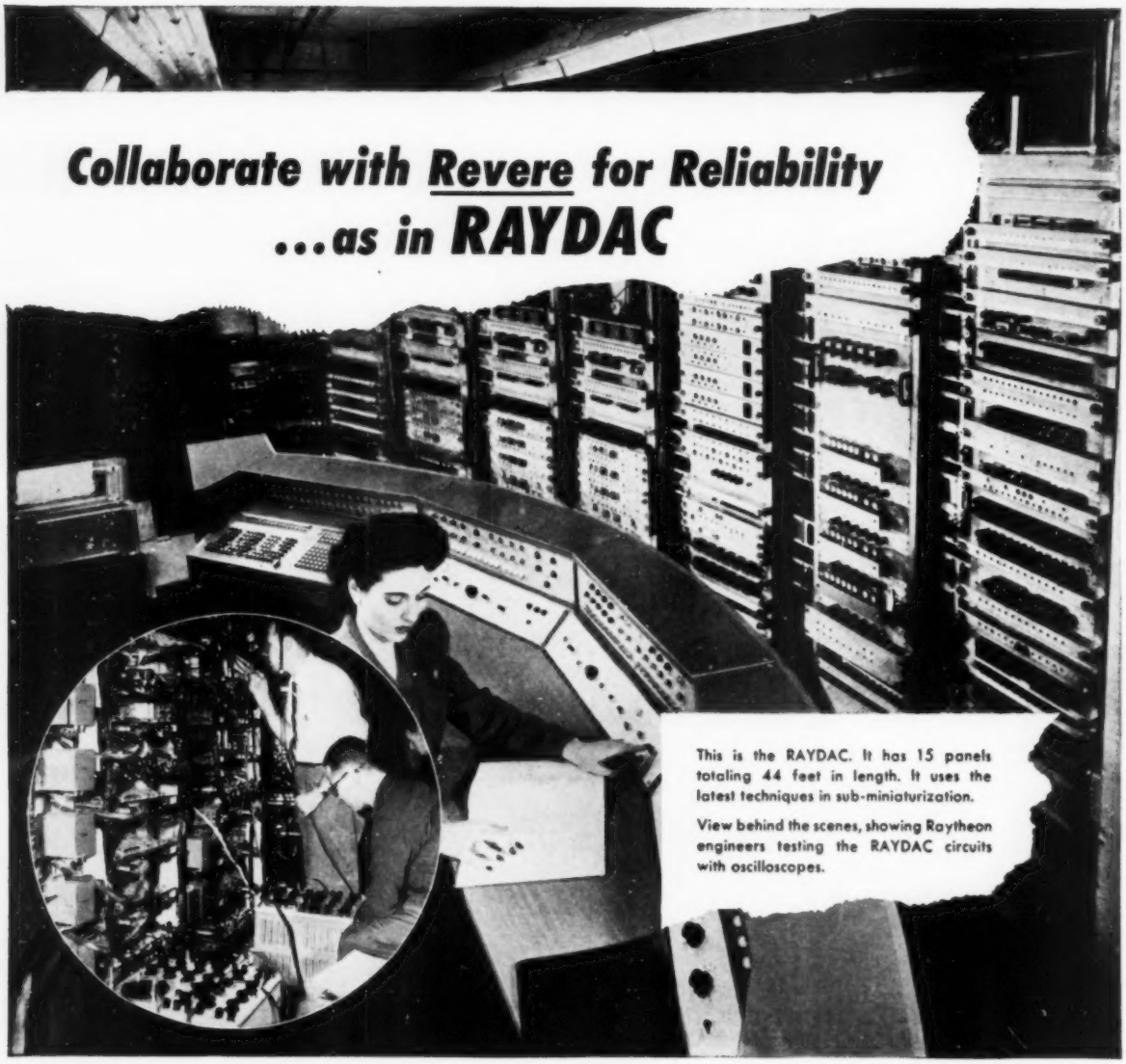

This is the RAYDAC. It has 15 panels totaling 44 feet in length. It uses the latest techniques in sub-miniaturization.

View behind the scenes, showing Raytheon engineers testing the RAYDAC circuits with oscilloscopes.

RAYDAC means Raytheon Digital Automatic Computer, developed by the Raytheon Manufacturing Company, Waltham, Mass., for the Navy's Bureau of Aeronautics. It is an "intelligence center" to help analyze the behavior of missiles during test flights. Its importance is indicated by the fact that in a matter of minutes it can perform the calculations involved in analyzing a single missile flight, a task that would take a team of mathematicians from 20 to 30 days. The Raydac thus speeds up tremendously the development and testing of such missiles. It contains enough tubes and germanium diodes made by Raytheon, for more than 1,000 home radio sets.

In such a complicated electronic computer reliability is essential. This is achieved through design, the choice of the best materials and components, and meticulous manufacture. Revere during the past 10 years has collaborated closely with Raytheon, working out proper specifications for materials, as for example, OFHC copper. Raytheon engineers and production men have visited Revere laboratories at New Bedford, Mass., and Rome, N. Y., and many Revere specialists have studied methods and processes in the Raytheon plants and laboratories. These hand-in-glove contacts, many of them highly confidential, have proved their value.

The same kind of collaboration is open to you, and will be especially useful and time-saving if begun as soon as you have a new project on your boards. To obtain it, simply get in touch with the nearest Revere Sales Office. See your telephone book or write direct.

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Product Engineering

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THIS MONTH'S COVER

Electrolytic tank used at the Research Laboratories of Sylvania Electric Products, Inc., to determine the electrostatic potential distribution of electrode systems used in vacuum tubes. An enlarged scale model of the electrode system in question is immersed in the electrolyte and potentials are applied to the electrodes in the ratios that exist in the tube.

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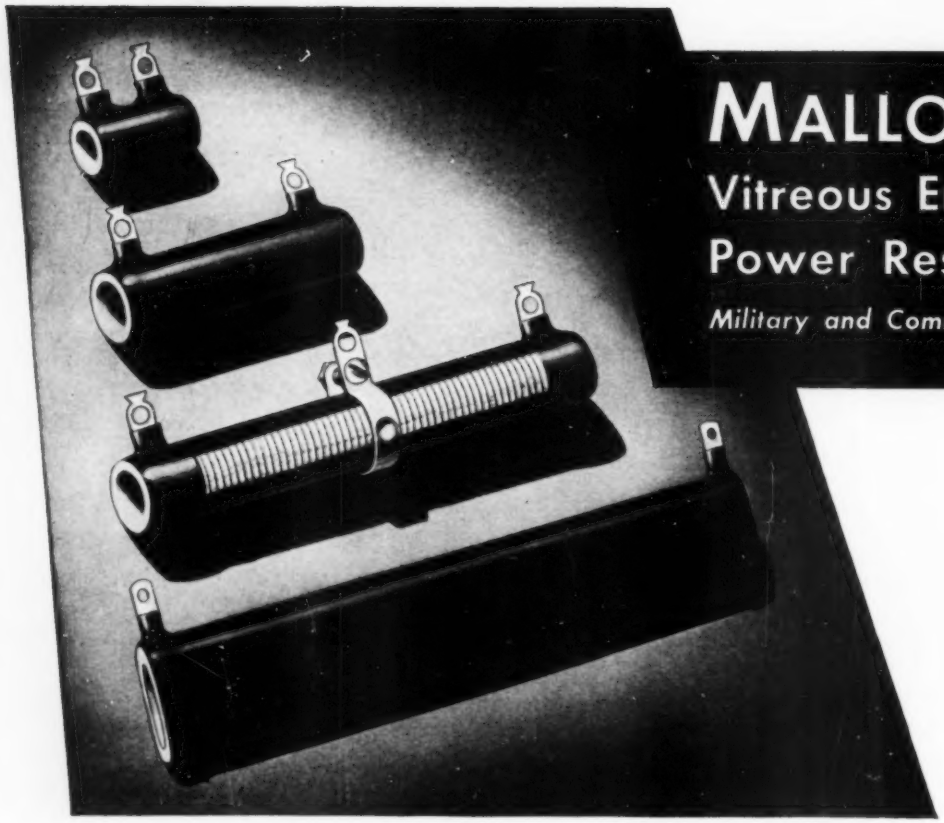
WHAT'S COMING

Articles on the analog computer and properties of "pop" riveted joints will highlight our May issue. Solenoid valves, client-consultant relationships, sheet metal gears, air-operated pilot control valves, and a simplified approach to spring design also will be covered in feature pieces written by top notch engineers with major industrial companies.



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Highlights

When requesting further information from companies and organizations mentioned in the items below, confusion can be avoided by referring to the issue of Product Engineering in which items appear

NONMETALLIC MATERIALS

PLASTIC COATING for use as protection and color identification on insulated piping and equipment has been developed by Armstrong Cork Co, Lancaster, Pa. The finish, called Insulcolor, can be brushed or sprayed on, will withstand temperatures to 160 F without cracking, shrinking, or crazing and has high resistance to abrasion and water. When dry, it is claimed to be fire retardant. It is also entirely odorless. The coating is available in a variety of colors.

A CERAMIC-METAL MATERIAL under development will allow engine combustion temperatures 200-300 F hotter than for materials now in use. Thompson Product Co, Cleveland, Ohio, claims that this titanium-carbide metal has a ductility about that of metallic alloys and that samples show excellent physical properties. Hardness is about equal to that of glass in the range of 90 Rockwell A but a 90 deg bend can be easily made if the radius is generous.

EXPERIMENTAL BATCHES of butyl titanate paint are being tested in the U. S. reports the Australian Commonwealth Scientific and Industrial Research Organization. Paints are reported to resist temperatures of 1,000 F, adhere to metals, glass and concrete and resist salt water corrosion. The paint is made from rutile and ilmenite extracted from Australian beach sand.

REINFORCED glass fiber thermosetting plastic pipe, available in 4 to 10 O D is a development of the Reflin Co, Gardena, Calif. The pipe is claimed to have a temperature range for continuous duty between -90 and +230 F. Low heat transfer rate allows transmission of hot or cold liquids with little loss. Working pressure is reported to be 200 psi and the burst pressure is 1,000 lbs per sq inch.

NEW UREA COMPOUND for use in molding large housings in color is a development of the Plaskon Div, Toledo, Ohio. Color is said to be molded in and scratch proof and the housings produced have the advantage of being heat resistant, non-electrostatic and non-combustible.

INCREASED USE of molded nylon plastic parts is forecast by GE Chemical Div, Pittsfield, Mass. It is claimed that nylon parts have superior performance, lower production costs, noise free operation and the elimination of many lubrication problems over most of the metal parts that they have replaced.

A HEAT RESISTING SILICONE electrical insulating varnish with three times the dielectric life of similar products has been developed by Dow Corning Co, Midland, Mich. At 482 F, company tests show a flex life of more than 1,000 hr and a craze life exceeding 3,000 hr. The coating cures at 482 Fahrenheit.

METALLIC MATERIALS

CREEP TESTING of nickel alloy steels are being determined continuously by a bank of creep machines. International Nickel Co. has 40 machines applying loads from 2,800 to 100,000 lb at temperatures of 700 to 1,800 F. In the development of new high strength and high temperature materials creep performance is determined at varying stresses and temperatures and plotted as a family of stress rupture waves.

UNDERGROUND CORROSION TESTS of hot-dipped galvanized steel pipe was recently completed by the National Bureau of Standards. Results show that three oz of zinc per sq ft of exposed surface makes the steel highly resistant to corrosion. Many of the specimens continued to show high corrosion resistance after the outer zinc coating and zinc-iron alloy layer had entirely corroded away.

(continued on page 7)

Look for a 1-Track Mind...

For Results in Thermosetting Moulded Plastics

Your thermosetting jobs are set for a clear right-of-way here at Kurz-Kasch. Compression, transfer and plunger moulding methods are what we are set up for expressly—both physically and mentally. Idea, of course, is to deliver all the advantages of specialization and experience.

You want a moulder strong on tool control and production, too—and that's the second strong part of our system. Matter of fact, we've just finished adding more mould-making capacity to one of the finest toolrooms in the business.

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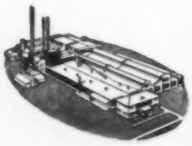

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IRON BEARING, single phase type of aluminum bronze has excellent characteristics for a new bolting material. Ampco Metal Inc, Milwaukee, Wis, reports the alloy to have toughness, good tensile strength, and corrosion resistance to salt water and some acids and alkalies. Properly processed, the alloy is not susceptible to intergranular corrosion or stress cracking.

STRENGTH, DUCTILITY and hardness of copper are effected by its prior strain history. National Bureau of Standards tests indicate that cold drawing at a fast strain rate results in increased strength and hardness but in decreased ductility. Prestraining at a high temperature, or low strain rate, results in reduced strength, hardness, and ductility of the copper.

MAGNESIUM ALLOY castings are possible by the shell molded process as a result of an Army research project. U. S. Dept of Commerce report PB 111,049 states that when suitable inhibitors are added to the plasticizers and the mixing procedure followed, satisfactory magnesium alloy casting are obtained.

EXPERIMENTAL STUDIES on the influence of induction heating on the properties of steel are being conducted by Lehigh University, Bethlehem, Pa. To control test samples heated in a high frequency induction furnace, a Leeds and Northrup Rayo tube sights on the sample and a controller automatically records and controls the temperature of the induction furnace.

PROCESSES

THE ELECTROPLATING of rhodium is commercially feasible by the use of a new process. Technic Incorporated, Providence, R. I., reports that heavy layers of the hard wear-resistant metal up to 0.001 in. can be achieved. Rhodium in the past has been limited to very thin plating thicknesses.

SYNTHETIC WAX BATH for stress relieving of molded nylon parts has been developed by the Glyco Products Co., Inc, Brooklyn, N.Y. Bath is heated to 350 F, and parts immersed for a specified period of time depending on wall thickness. It is claimed that the bath protects the parts against dimensional changes and shrinkage.

BRAZING AND CARBURIZING in the same salt bath are possible according to Ajax Electric Co, Philadelphia, Pa. The salt acts as a flux for the brazing material and the steel. If after proper preparation for brazing the parts are immersed in a carburizing bath, the brazing will occur as well as the carburizing. The secret of the process is to have the molten salt control the temperature within 5 F over the assembly.

PREPARATION of aluminum surfaces for welding can be speeded using a new process developed by Northwest Chemical Co., Detroit, Mich. Called Alkalume, the process removes soils and oxides without harming the metal. It is claimed to eliminate mechanical cleaning operations and give more perfectly formed welds free from cracks. Welds average well above allowable shear strength due to the thorough metal cleaning claimed for the process.

DEVELOPMENT of a rapid, convenient method for purifying zirconium is reported by the National Bureau of Standards, Washington, D. C. Process leads to zirconium sulfate of high purity. Previously, laboratories have had to use zirconium in whatever purity it could be purchased, the purer the metal the higher the cost.

COMPONENTS

MAGNETIC BRAKE that holds constant tension on wire or yarn by magnetic drag instead of friction is a development of GE's Control Dept, Schenectady, N. Y. Alnico magnets create a magnetic drag on a pulley that is constant at all speeds. The brake is said to reverse the direction of rotation a few degrees after stopping, thereby holding stalled tension on the wire or yarn being used.

WIDE-TEMPERATURE-RANGE capacitors of 100, 200, 400 and 600 v range at 0.001 to 1.0 mfd are a development of GE's Capacitor Dept, Hudson Falls, N.Y. Temperature range is -55 C to +85 C and capacitors are claimed to be 20 percent smaller than comparable units. Silicone bushings have replaced the brittle glass end-seals normally used on other capacitors. The bushings provide an excellent hermetic seal.

(continued on page 9)

Wear is a problem wherever two surfaces slide or roll against each other. Parco Lubrite, one of the Parker line of surface treatments for metals, *retards* wear on iron and steel.

Parco Lubrite converts the surface of metal parts to a non-metallic phosphate coating that is oil absorbent, holding lubricant even under high unit pressures. In initial operation the Parco Lubrite coating prevents metal-to-metal contact, and break-in is quick, easy and smooth, without galling or scoring.

Parco Lubrite treated parts can be expected to have longer service life, too. You will want to know just how Parco Lubrite can contribute to the performance of the friction parts in your product. **Write today for full information.**

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**Bonderite, Bonderlube, Parco, Parco Lubrite, Reg. U.S. Pat. Off.*

BONDERITE—corrosion resistant paint base • **BONDERITE and BONDERLUBE**—aids in cold forming of metals • **PARCO COMPOUND**—rust resistant • **PARCO LUBRITE**—wear resistant for friction surfaces

CIRCUIT BREAKERS, with an interrupting rating of 25 million kva at 330 kv are to be constructed by the Westinghouse Electric Corp. Operating in connection with sensitive relaying equipment, the oil-breaker will automatically remove short circuits or faults within 1/20 sec, and if desired, reactivate the circuit within 1/3 sec if the fault has been corrected.

AN INSTRUMENT capable of measuring the true mass rate of flow through a pipe has been developed by the Control Engineering Corp, Norwood, Mass. The meter responds to lb and is insensitive to volume. Direct measurements in lb per min, or with integration lb, can be made on gases, liquids or particles in an air stream. Accuracy of measurements, , it is claimed, is independent of volume, temperature, pressure, viscosity, compressibility or external accelerations of the mass being measured.

ULTRASONIC CLEANER uses high frequency waves to clean oil, dirt, and other contaminants from metal parts. A development of the Topper Equipment Co, Clark Township, N. J., the machine has a GE ultrasonic generator used in conjunction with specially developed vapor degreasing equipment and techniques. Continuous production or batch type methods can be used.

AN A-C MOTOR designed to operate at altitudes of 50,000 ft with take-off shaft speeds of 7,300 rpm is a development of U. S. Electrical Motors Inc, Los Angeles. The 1/2 hp, 400 cycle, 3 phase motors are totally enclosed, self-ventilating with thermal overload protection. They have high accelerations and high starting torques. Present application is aircraft.

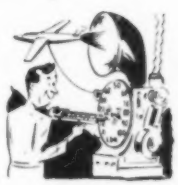
HYDRAULIC HOSE COUPLINGS make a leakproof joint at pressures to 5,000 psi when hand tightened. The developers, Eastman Mfg. Co, Manitowoc, Wisc, have tested the new couplings at 5,000 psi on hoses from 1 to 1 1/4 ID using standard O-ring seals.

TESTING

46 INDEPENDENT CIRCUITS are available on a short slip-ring assembly developed by Electro Tec Corp, South Hackensack, N.J. For use as a miniaturized lightweight test unit, it has a length of 1.935 in. Individual rings are 0.023 in. wide with 0.020 in. barriers between rings.

PORTABLE VACUUM TESTER for use on small fuel tanks, diaphragms, bellows and pneumatic valves is a development of Gits Bros. Mfg. Co., Chicago, Ill. Said to be adjustable for vacuum and time cycle, the system includes a vacuum pump, testing plate, and instrument panel.

FOR RAPID TESTING of electronic components a general-purpose comparison bridge is available from General Radio Co, Cambridge Mass. The bridge is self-contained, operates at 1 kc or 5 kc and can measure impedance difference and dissipation-factor difference for resistors, capacitors and inductors.

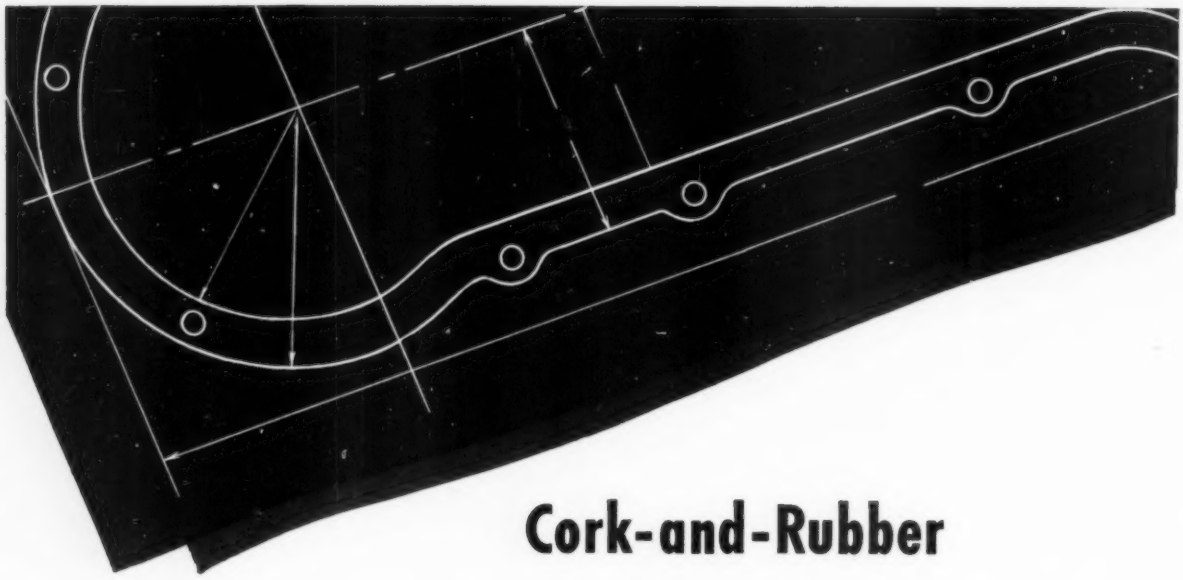


JET POWER can be measured by use of a hydra brake. Its developers, Industrial Engineering Co., Philadelphia, Pa., states that the test unit is a water brake-type dynamometer that uses heat rise to measure power. It is claimed that mounted to an engine drive pad it can measure power loads to 1,000 hp. Weight of the unit is 35-55 pounds, and it is 14 inches long.

ULTRA-FAST CAMERA operates at speeds to 3,500,000 frames a second. Developed by University of California, Los Alamos Scientific Lab. The camera is a continuous-writing rotating mirror type; useful for high speed events that are selfluminous or illuminated by very intense explosive light sources.

HIGH CAPACITY VIBRATOR that can hold a 6,000 lb load on a 5 by 6 ft table is a recent Navy development. The reaction type machine is claimed to have a maximum 50,000 lb force, remote controls, great accuracy of vibration, easy change of amplitude and excellent efficiency. The four-ton machine is mounted on casters.

RECENT DEVELOPMENTS have made it necessary to extend heat measurements to both very high and very low temperatures. The National Bureau of Standards claims that benzoic acid will be useful as a standard when a solid is needed at below 80 C. n - heptane as a liquid standard up to 130 C, aluminum oxide to 900 C and up to 2,000 C as soon as accurate measurements of its heat capacity are available at the higher temperatures. A fourth material, diphenyl ether, has been suggested as a heat capacity standard, however, no tests have been made.



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- **Synthetic rubber compounds.** Armstrong makes special synthetic rubber compounds for certain highly critical applications. If you need an out-of-the-ordinary rubber compound, get in touch with us.

ARMSTRONG'S GASKET MATERIALS

Armstrong supplies a cork-and-rubber compound to meet each of the 8 types included in the principal government specifications covering these materials.

Here's a list of these compounds:

Specification	Material	Specification	Material
MIL-G-6183			
Type I Soft	NC-709	Type II Soft	DC-167
Type I Medium	NC-710	Type II Medium	DC-100
Type I Firm	NC-711	Type II Firm	DC-113
MIL-T-6841	DK-153 or RK-304S	MIL-G-6747	DK-149

For samples and additional information, call your nearest Armstrong office or see "Armstrong's Gasket Materials" in Sweet's file for product designers.

This 24-page manual gives you information on current government specifications and tentative SAE-ASTM specifications, as well as much helpful information on the design and use of gaskets.

Send for this gasket manual

"Armstrong's Gasket Materials" includes sections on designing gaskets to reduce costs, practical tolerances for resilient gaskets, designing flanges for efficient sealing . . . and many others.

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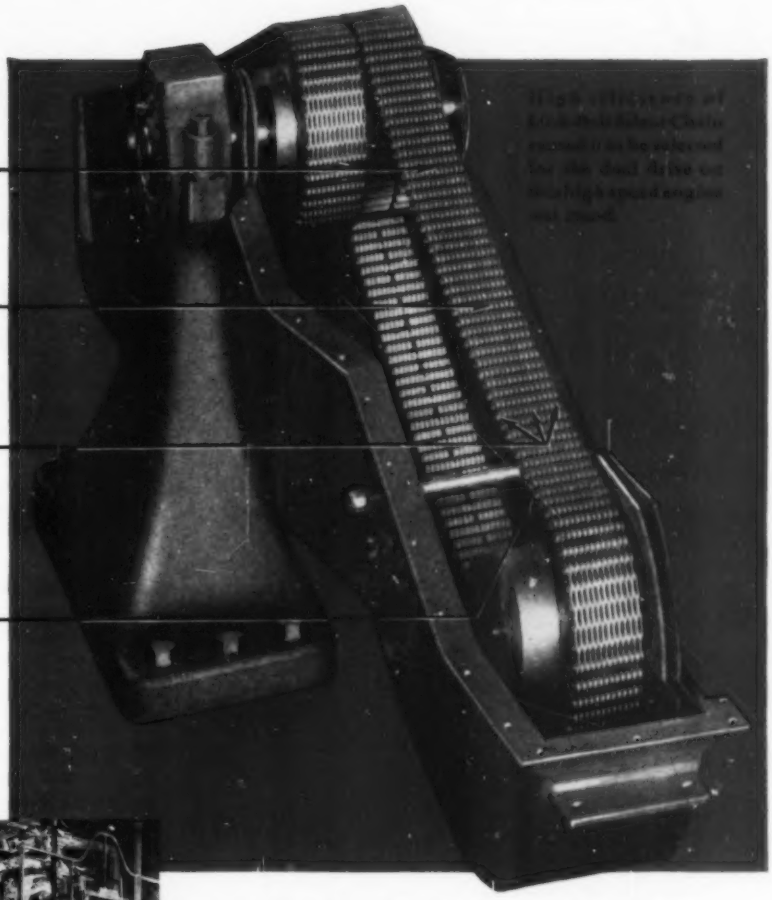
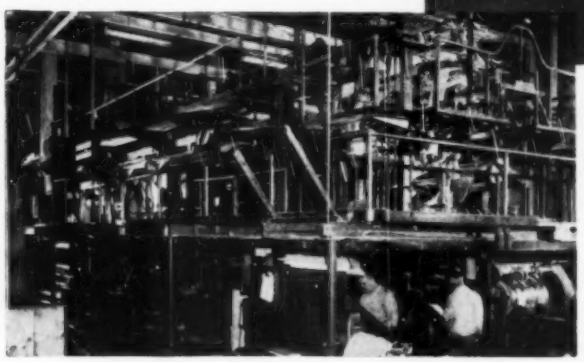
"Pull" is distributed equally across Silverstreak Silent Chain. No possibility of uneven running—slapping.

Silverstreak Silent Chain doesn't rely on tension to get pulling power—chain meshes with teeth—gives POSITIVE drive—no chance for slip.





Four 125 hp Silverstreak Silent Chain Drives power this press on which 46% of all "Readers Digest" copies are printed. Chain speeds of 4600 fpm are maintained 24 hours a day, six days a week.

LINK-BELT

SILVERSTREAK SILENT CHAIN DRIVES

LINK-BELT Silverstreak Silent Chain Drives are slip-proof ... slap-proof ... shock-proof

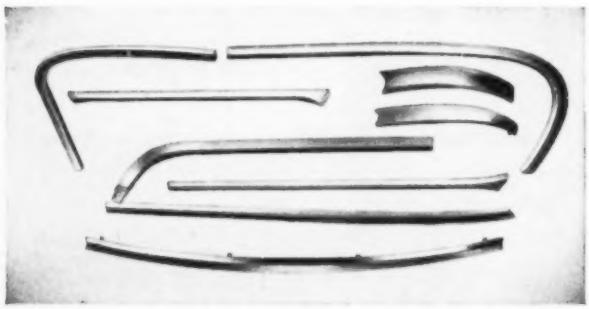
For the finest in modern power transmission, use Silverstreak Silent Chain the next time you have a demanding drive problem. These long-life drives—more than 98% efficient—have met every test for rugged service. There are many applications where Silverstreak Silent Chain has been in continuous operation for 15 years and more ... without replacement ... with only routine attention. Call the Link-Belt power-transmission engineer in the office near you for any information you require.

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 12.053

LOOK TO
STUDEBAKER
for '53

— get the mo$t
for your Zinc Die
Ca$ting Dollar!

Many of the above ZINC Die Castings can be readily identified on the 1953 Studebaker front view. The other castings are employed on the rear deck and fenders. Castings pictured below are used on various Studebaker models, in keeping with the trend to more and more ZINC Die Cast window and body moldings.



While the new Studebaker breaks sharply with American contemporary design, reflecting the influence of European styling, the engineering continues to be based strictly on American mass production techniques. That means a widespread use of ZINC Die Castings.

From the low front profile to the fin-like rear fenders, the sleek new Studebaker models are "tailored" with the ZINC Die Castings shown at the left. The ability to die cast complex shapes with exacting dimensions in ZINC makes it possible not only to achieve unusual designs, but to produce the part to fit the body section, instead of vice versa. These production advantages, plus the ability to take and hold beautiful plated and enamel finishes, have made the automotive industry the largest consumer of ZINC Die Castings.

Ask any commercial die caster about the physical and mechanical advantages of ZINC over other die casting metals—or write to us.

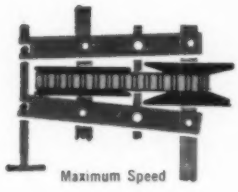
Send for
your copy

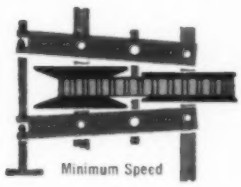
ZINC
FOR DIE CASTING ALLOYS

The New Jersey Zinc Company, 160 Front St., New York 38, N. Y.

The Research was done, the Alloys were developed, and most Die Castings are based on
HORSE HEAD SPECIAL (99.99 + % Uniform Quality) ZINC

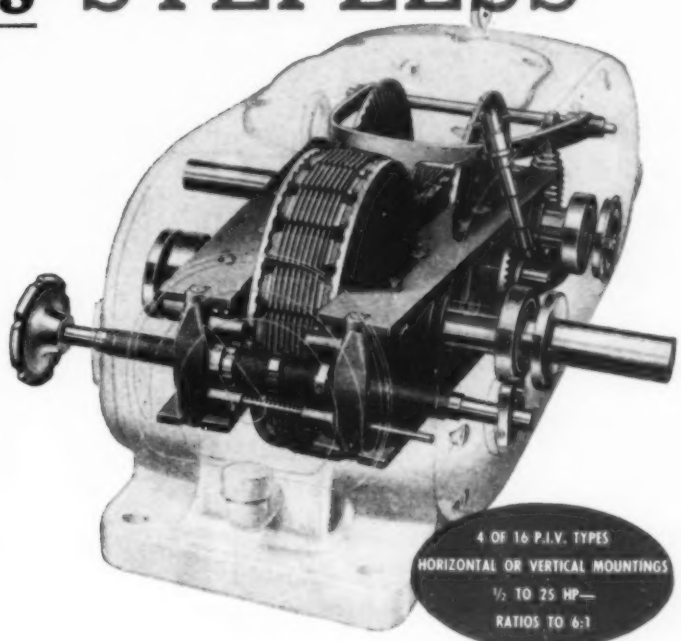
Always POSITIVE...
Always STEPLESS





Note how the effective diameter of P.I.V.'s wheels can be altered to change their ratio. You can select any point—from maximum to minimum setting—and get positive, accurately maintained speed.

ALL INDUSTRY USES P.I.V.*
*Positive, Infinitely Variable



4 OF 16 P.I.V. TYPES
HORIZONTAL OR VERTICAL MOUNTINGS
½ TO 25 HP—
RATIOS TO 6:1

P.I.V. Variable Speed Drive gives you infinite speed choices

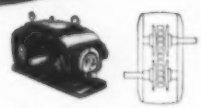
SELECT ANY SPEED within normal operating range, and you can always be sure Link-Belt's P.I.V. Variable Speed Drive will maintain it accurately under full load conditions.

P.I.V. is not dependent on friction for power transmission. Self-tooth-forming chain meshes with grooved wheels to provide positive, infinitely variable speed selection. Using P.I.V., your machines are capable of working to maximum capacity according to the job. Control can be manual or automatic while running under full load.

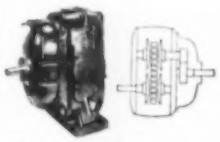
Link-Belt's P.I.V. Variable Speed Drive is compact. It is particularly adapted to delicate or sensitive manufacturing processes that require exacting variable speed transmission. Find out how you can increase the flexibility and efficiency of your machines. Call your nearest Link-Belt office today for complete, detailed information. Send for Catalog No. 2274.

LINK-BELT
P.I.V. VARIABLE SPEED DRIVE

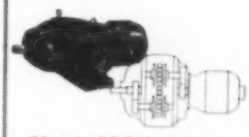
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,115



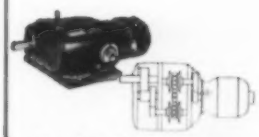
Basic, Positive, Infinitely Variable (P.I.V.) Speed Drive.



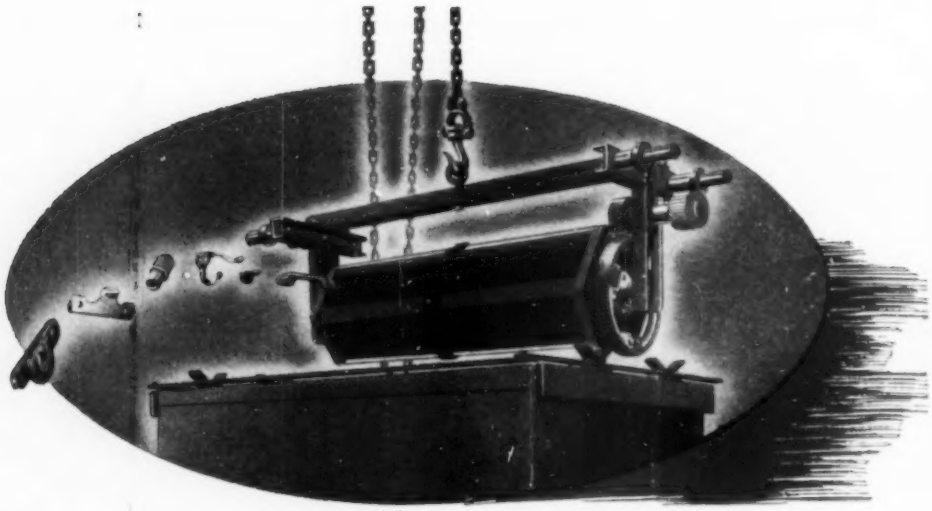
P.I.V. with single reduction input or output helical gears.



Motorized P.I.V. with single reduction input and output helical gears.



Motorized P.I.V. with single reduction input and double reduction output helical gears.



Plating on Aluminum made EASY with Alumon

Hundreds of manufacturers throughout the United States are now using electroplated aluminum. The Alumon process is simple. The work is merely cleaned, dipped in acid, dipped in Alumon and is then ready for electroplating with copper, nickel, and other metals. The process is suitable for plating most wrought and cast alloys. . . The cost of using Alumon is low, being less than half a cent per square foot of surface area treated. The process can be fitted easily into regular plating cycles. Bulk or barrel plating readily done. Upon request we'll gladly send you the Alumon Process Bulletin.

Write for literature on Alumon and check list of literature on sixty Enthone products and processes for better metal finishing.

*TRADE-MARK REG. U. S. PAT. OFF. MANUFACTURED UNDER U. S. PATENT 2,142,564.

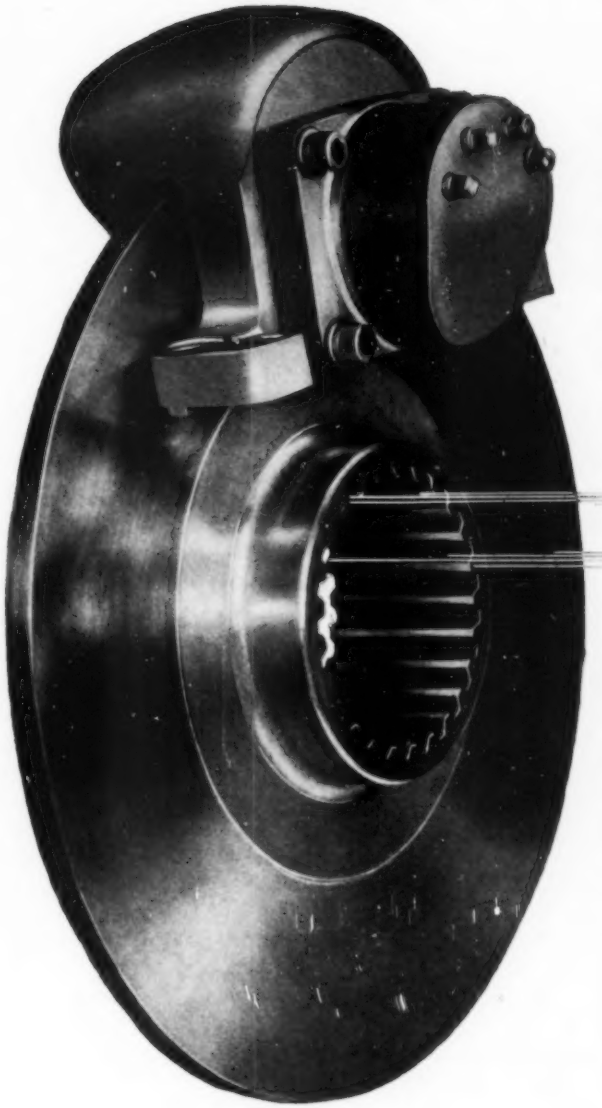
METAL FINISHING PROCESSES

ENTHONE
INCORPORATED

ELECTROPLATING CHEMICALS

442 ELM STREET
NEW HAVEN, CONNECTICUT

Presenting aircraft-type DISC BRAKES for Industry



A new braking principle for industry —an outgrowth of success in aviation

UNIVERSAL APPLICATION—the Goodyear Disc Brake can be adapted to almost any machine—can be operated hydraulically, mechanically, pneumatically or can be spring-set, solenoid-released.

HIGH ENERGY CAPACITY—heat dissipation is accelerated by the exposed-disc design. Rapid cooling results in increased energy capacity. For applications requiring maximum cooling, a vaned-type rotating disc can be used. This type disc has several times the capacity of a solid disc of the same diameter.

VARIABLE TORQUE CAPACITY—torque capacity for any disc size can be varied by using different number of cylinders. Many combinations of torque and energy values can be obtained.

SMOOTH ACCURATE CONTROL—the brake produces a practically straight torque line with equal torque in either direction. The smooth operation makes the brake ideal for transmission or drive-shaft applications.

AUTOMATIC ADJUSTING—hydraulic- and air-actuated units have automatic compensation for lining wear. Mechanical and spring-set types have a simple, external, manual adjustment.

SIMPLE LINING REPLACEMENT—the relining of this "spot" type brake requires much less time than other types. No special tools are needed and the simplicity of the operation of replacing the small circular linings results in reduced equipment "down time" and minimum expense for brake relining.

This new Industrial Disc Brake is an application of the braking principle used to stop the largest and fastest aircraft in existence—now being applied to difficult industrial braking problems with outstanding success. Goodyear backs these brakes with 22 years of design and production experience. Write for brochure containing complete information; address: Goodyear, Industrial Brake Dept., Aviation Products Division, Akron 16, Ohio.

INDUSTRIAL DISC BRAKES BY

TYPE I
Floating disc and fixed housing

TYPE II
Fixed disc and floating housing

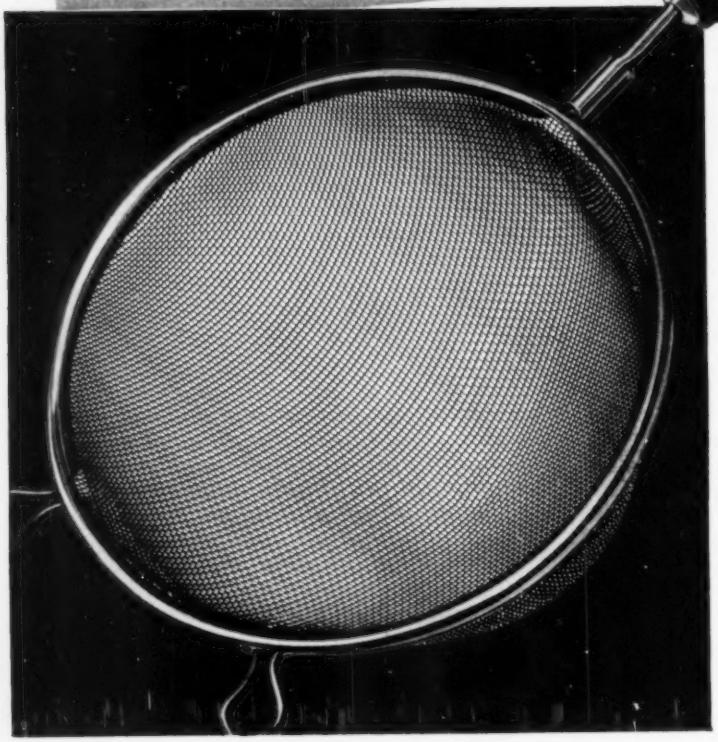
TYPE III
Fixed disc and fixed housing with opposed cylinders

GOODYEAR
AVIATION
PRODUCTS

We think you'll like "THE GREATEST STORY EVER TOLD"—every Sunday—ABC Radio Network—THE GOODYEAR TELEVISION PLAYHOUSE—every other Sunday—NBC TV Network

TINNED--
FOR PROTECTION

...in preparing and processing foods... beverages... and petroleum products



Why are kitchen strainers, tea strainers, flour sifters, french fryers, automatic dish washer baskets and many other kitchen tools made of Reynolds *tinned* wire cloth?

Because tinning means resistance to rust and tarnish resulting from contact with milk, water and atmospheric gases.

Tinned wire cloth is also resistant to phosphoric acid, ammonia, carbon tetrachloride, etc.; and substances present in motor fuels and other petroleum products.

And, wherever high speed soldering is a factor—as in electrical products—Reynolds tinned wire cloth is a natural.

Whether your products are used in the kitchen, dairy, food processing and preservation, or the beverage, petroleum, or electrical industries—you'll be interested in Reynolds Wire Cloth. And, tinning is only *one* of the many special-needs demands that *Reynolds* Wire Cloth is or can be made to meet. Consult Reynolds engineers. No obligation.

Reynolds WIRE CLOTH
protects performance

REYNOLDS WIRE DIVISION, NATIONAL-STANDARD CO., **DIXON, ILLINOIS**

Divisions of National-Standard Co.

ATHENIA STEEL...*Clifton, N. J.*.....Flat, High Carbon, Cold Rolled Spring Steel
NATIONAL-STANDARD...*Niles, Mich.*.....Tire Wire, Fabricated Braids and Tape
WAGNER LITHO MACHINERY...*Jersey City, N. J.*.....Metal Decorating Equipment
WORCESTER WIRE WORKS...*Worcester, Mass.*....Round and Shaped Steel Wire, Small Sizes

NS NATIONAL STANDARD Company NILES MICHIGAN

Everyone Can Count on VEEDER-ROOT

REPORTER AT LARGE . . . that's what you might call this new Veeder-Root Reset Magnetic Counter . . . adaptable to remote counting from machines or processes to central boards or instrument-clusters, wherever you want to put them. NOW . . . what can your imagination do with these few facts? For the *full facts*, write:

VEEDER-ROOT INCORPORATED

"The Name That Counts"

HARTFORD 2, CONNECTICUT

Chicago 6, Ill. • New York 19, N. Y. • Greenville, S. C.
Montreal 2, Canada • Dundee, Scotland
Offices and Agents in Principal Cities

"Counts Everything on Earth"

"These American Springs are better —and they cost less"

says Overhead Door Corporation

You don't have to be a Hercules to open these doors, because all the muscle-power is furnished by American Quality Springs. The door and springs are so delicately balanced that the massive 16-foot, 340-lb. garage door can be operated easily.

The American Springs for this application must withstand very large deflections (from 27″ to 48″). They must exert a constant force as the door is raised and lowered; and they need a healthy amount of reserve strength for long life.

Failure is no problem with these American Quality Springs. As a matter of fact, Overhead Door

ANYBODY can open this 16-foot, 340-pound door. The American Quality Springs exert a constant pull, and allow effortless action.

AT TOP OF PHOTO, notice how far these American Quality Springs must deflect in the "OVERHEAD DOOR."

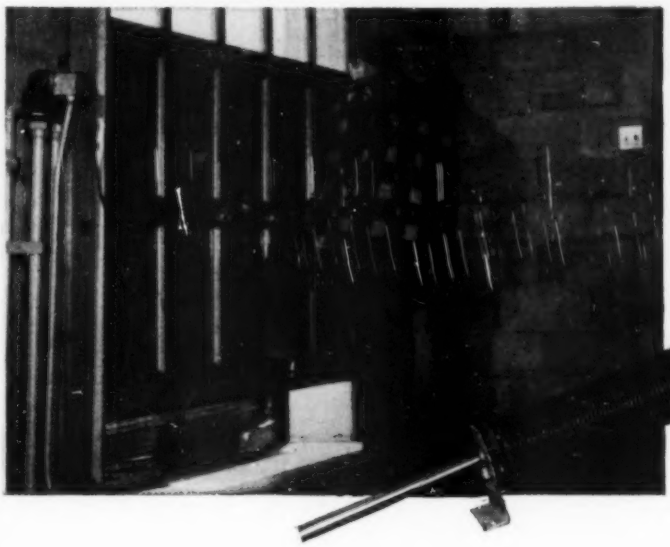
than counterweights

Corporation says, "We have been building doors for 32 years and practically all of those original doors still have their original springs."

The Overhead Door Corporation prefers a spring system (instead of counterweights) for two big reasons—and the most important one is cost. They get 500 pounds of pull from a spring at 25% less cost than if they used iron weights. Also, anyone who opens a spring-loaded door does not have to overcome the inertia of door plus weights. The door is practically weightless the instant you move it.

American Steel & Wire can produce and help you design a spring for just about any application, any size, any steel or finish. Let our skilled spring engineers show you how low in cost a truly superior spring can be. Call our nearest District Sales Office or write to American Steel & Wire Division, Rockefeller Building, Cleveland 13, Ohio.

"OVERHEAD DOORS" are widely used for industrial applications. Many of these industrial doors have been opened 100-150 times daily for *20 years* without a spring failure.



OVERHEAD DOOR CORPORATION also makes many doors utilizing torsion springs. This spring is actually twisted around a shaft when it "winds up." Despite the high stresses, these American Quality Springs give trouble-free service.

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S American Quality Springs

UNITED STATES STEEL

Solve Design and Production Problems with

Roll Formed Aluminum Shapes from Reynolds

Roll formed shapes offer economy, dimensional accuracy, better finishes and design flexibility. They are available in a wide range of shapes that are easily bent, welded, assembled and generally fabricated. Add the many advantages of light, strong, non-rusting, low cost aluminum and it's easy to see why so many of today's top designs call for roll formed aluminum shapes.

HERE'S WHY IT PAYS TO CALL ON REYNOLDS ALUMINUM FABRICATING SERVICE FOR YOUR ROLL FORMED ALUMINUM SHAPES

Experienced, competent help on your design problems is readily available from Reynolds design and engineering service. Capacity for prompt, economical production of your roll formed shapes is also assured—thanks to Reynolds sizable investment in roll forming machines and tooling. And, quality control from mine to finished part is still another "reason why" for obtaining your roll formed shapes from Reynolds.

Look into the advantages of roll formed aluminum shapes from Reynolds. Contact your Reynolds office listed under "Aluminum" in your classified telephone directory or write Reynolds Aluminum Fabricating Service, 2051 South Ninth Street, Louisville 1, Kentucky.

AUTOMOBILES

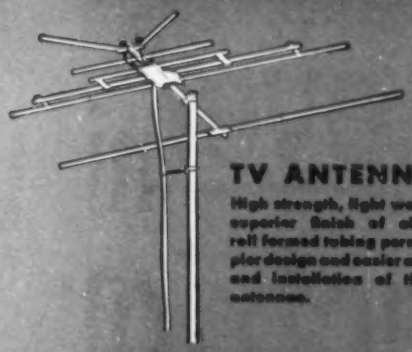
Complex shapes required for automobile parts and trim are easily and economically produced by roll forming. Close tolerances present no problem with this process.

Write for your free copy of the new catalog "Aluminum Roll Formed Shapes By Reynolds"

Be sure to see "Mr. Peepers" every Sunday night, 7:30 EST, NBC-TV; hear "Fibber McGee and Molly" every Tuesday night, 9:30 EST & PST, NBC.

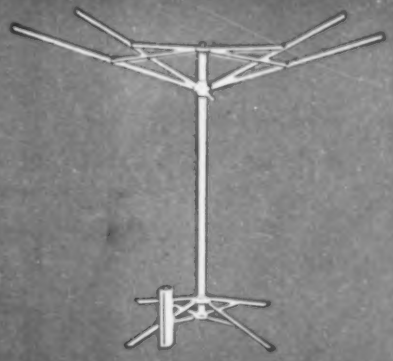
REYNOLDS ALUMINUM

BLANKING • EMBOSSING • STAMPING • DRAWING • RIVETING • FORMING



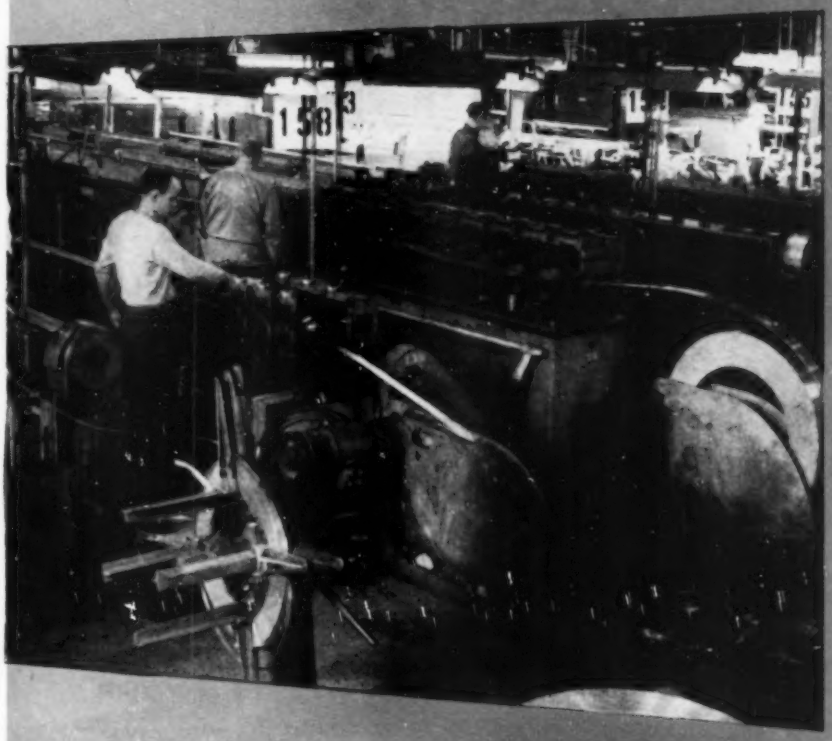
TV ANTENNAE

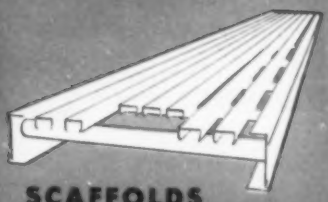
High strength, light weight and superior finish of aluminum roll formed tubing permits simpler design and easier assembly and installation of these TV antennae.



CLOTHES DRYERS

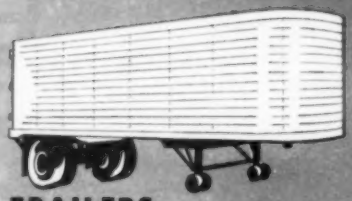
Roll formed shapes permit smoother finishes—eliminate need for finishing operations in these clothes dryers. Fine finishes required for decorative trim on metal furniture, counters, etc., are easily obtained by roll forming.





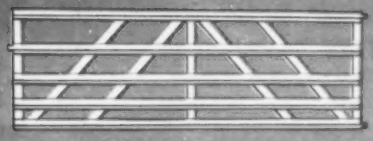
SCAFFOLDS

The sturdy appearance of aluminum roll formed shapes helps build rapid market acceptance for these scaffolds and countless other products.



TRAILERS

This all-aluminum trailer body uses many strong, attractive, easily assembled roll formed shapes. Aluminum's light weight and durability make it the ideal metal for such uses.



RANCH GATES

High strength and resistance to corrosion eliminate maintenance on these farm gates made from aluminum roll formed shapes by Reynolds.

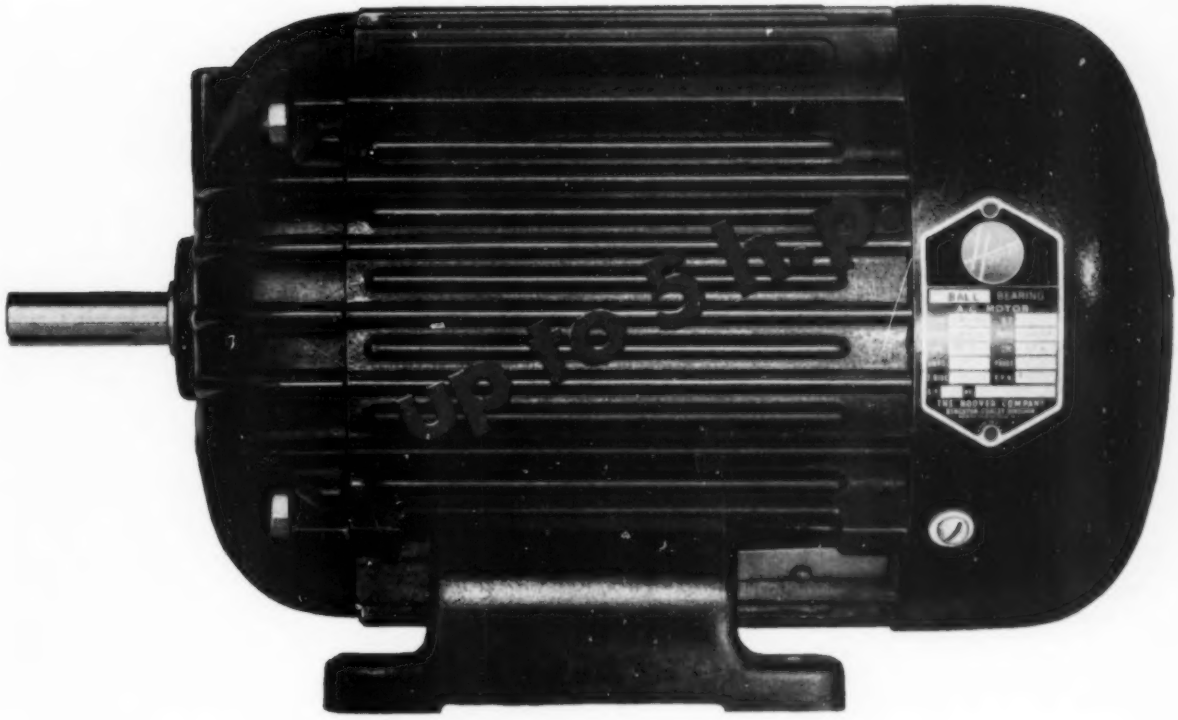
FABRICATING SERVICE

ROLL SHAPING • TUBE BENDING • WELDING • BRAZING • FINISHING

Hoover Electric Motors

Rugged, smooth-running jobs...

- Wide range of in-production models or, write your own set of specifications.
- Capacitator start and polyphase. Rigid, resilient, or face-mounted types (all built in standard NEMA frame sizes). Open, drip-proof or totally enclosed models.
- Compact design—means more horsepower per pound—more horsepower per cubic inch of space.
- Reliable starting switch, dependable windings, rugged rotor, double shielded bearings. Built to take the grind of long operating cycles or the punishment of frequent starts and stops.
- Cool running, quiet running, efficient, and powerful.
- Greater economy of initial cost, operating cost and upkeep.



and what a set-up for service...

For You:

There's a Hoover sales office or agency located in or near every manufacturing center in the country. A qualified Hoover engineer is always ready, willing and able to work with you on your specific motor problems. Check the map and listing at right for the address and phone number of the Hoover representative nearest you. In addition, Hoover distributors and dealers are located in principal cities throughout the U. S.

Write for information to:

THE HOOVER COMPANY
Kingston-Conley Division
North Plainfield, New Jersey

For Your Customers:

Even when the motor is on your product, Hoover still feels that it's "our baby." And wherever your products are sold and used—in the United States, Canada, Europe, Africa—Hoover's world-wide service agency system helps back up your (and our) good reputation.

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T. A. Steeds Co., Agents
San Francisco, 357 Ninth Street, Hemlock 1-7893
Marwood Limited, Agents

Colorado
Denver, 4949 Colorado Blvd., Dexter 5434
Peterson Co., Agents

Connecticut
West Hartford, P.O. Box 401, Hartford 33-1468
J. J. Daggon, District Manager

Georgia
Atlanta, 454 Marietta St., N.W., Walnut 3183
Napper & McCoy, Inc., Agents

Illinois
Chicago, 646 North Michigan, Superior 7-8892
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Seattle, 312 Occidental Ave., Mutual 0186
Shaffer & Nelson, Agents

Wisconsin
Milwaukee, 2947 No. 3rd St., Locust 2-2023
R. I. Bratt, District Manager

WHAT *Life-Line* REALLY DELIVERS IS MORE SERVICE...LESS SERVICING

Two smooth ideas for designers with vibration problems

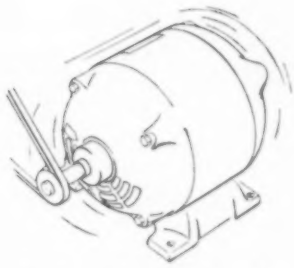
Vibration, shock, physical impact. How often does your design call for motors and controls that must operate under these conditions? The extra ability to stand up to slam-bang abuse . . . to teeth rattling blows is inherent in Life-Lines.

Consider the Life-Line motor. Heavy steel construction gives far greater shock resistance and protection to motor parts. Severe stresses of heavy loads, transmitted through motor frames and feet are easily withstood by Life-Lines. There is no distortion of laminations; no broken feet as in cast equipment. Further, steel adds this strength without adding bulkiness, actually reduces weight. You save space, weight; you gain strength, ruggedness.

Or look at the Life-Linestarter®. Vibration or accidental impact, in fact, jarring slamming blows do not cause false operation with resultant motor stoppage. That's because Life-Linestarters employ inverted clapper-type design. Contact opening *does not depend on gravity.* Positive kickout spring speeds operation. Result? No faulty operations from accidental blows . . . from jarring . . . from vibration.

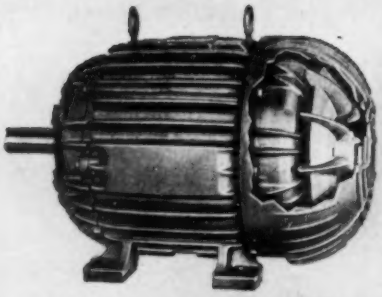
Remember, too, Life-Lines advanced modern designs cost no more than conventional design. You get more with less servicing —equipment built to match the advancements in the equipment you design. A call to your local Westinghouse representative will bring you complete information; or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21702-A

Life-Linestarters withstand jarring blows without faulty operation.

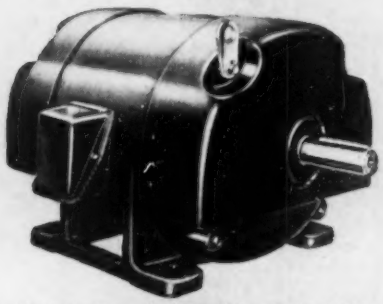


Steel stands up . . . reduces outages . . . saves costly replacement.

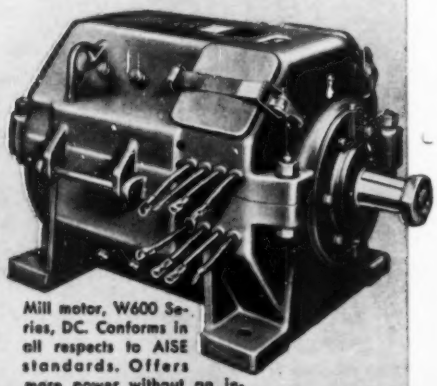
YOU CAN BE SURE...IF IT'S Westinghouse



"Sealedpower" totally-enclosed squirrel-cage motor. Cooled and cleaned by exterior fan-driven air blast directed along radiating fins. 3 to 125 hp. Explosion-proof, 20 to 125 hp.



Squirrel-cage splash-proof Form BA. Has corrosion-resistant covers which prevent entrance of splashing liquids.



Mill motor, W600 Series, DC. Conforms in all respects to AISE standards. Offers more power without an increase in the frame size.

Want quick stops-often?

here's the brake for it!

go • stop

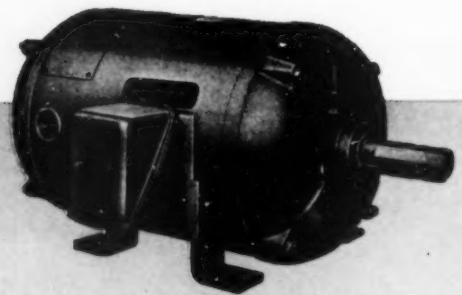
the

The positive-acting, tough and enduring C-W brake can be supplied with any Crocker-Wheeler integral motor. It is also available as a separate unit for mounting on double shaft extension NEMA standard D flange motors, frames 203-326, or C face motors, frames 364-405. It needs no mounting brackets or adapters.

GET BRAKE MOTOR BULLETIN SL-610-1, addressing your request to Elliott Company, Dept. PE, Jeannette, Pa.

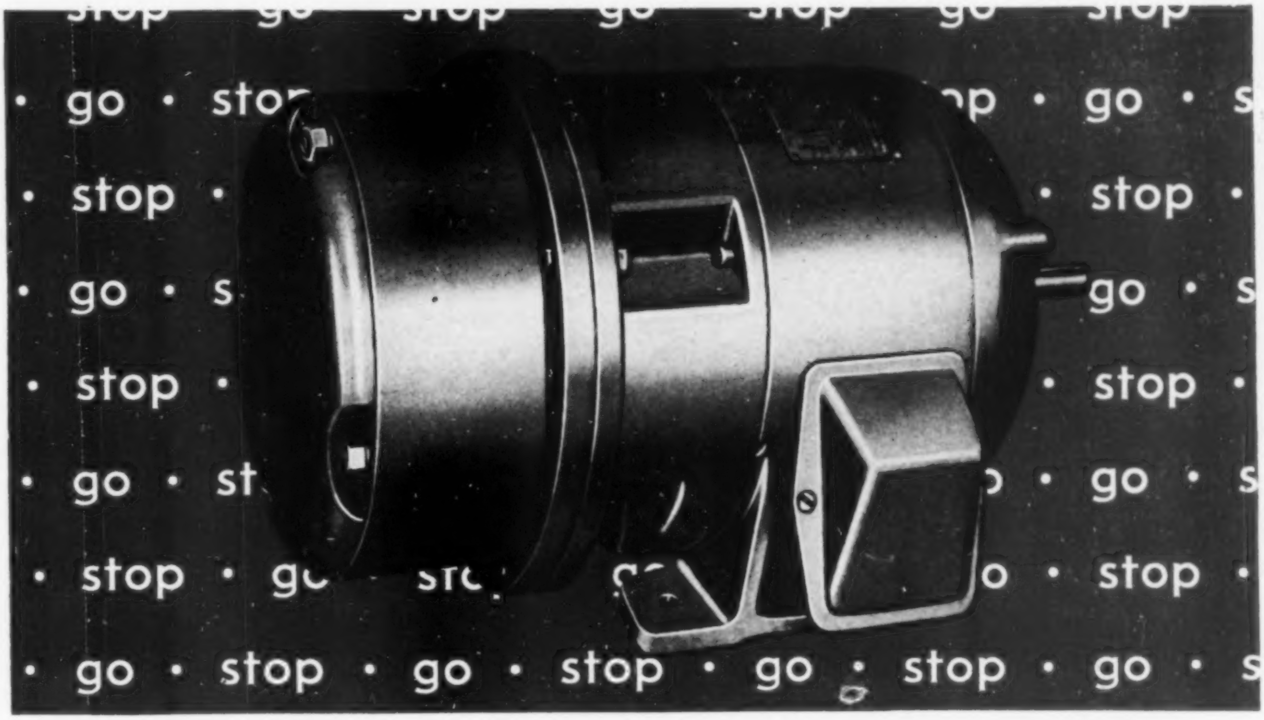
Crocker-Wheeler motors range from 1 to 200 hp. Larger Elliott motors and generators are built by the Ridgway Division at Ridgway, Pa.

...with the ELLIOTT CROCKER-WHEELER complete motor line, you can meet 'most any integral motor need!



Wound-rotor protected type Form BW. For slow, smooth acceleration, high starting torque with low starting current, or variable speed. Drip-proof, splash-proof, 1 to 200 hp.

W8-9



ELLIOTT CROCKER-WHEELER *Brake* MOTOR

The bonded metal brake linings of the C-W brake give greater friction for quicker stops, greater wear resistance, complete immunity to climatic conditions, oil or grease, and long service with no change in retarding torque.

The unusually short overhang of the C-W brake provides maximum rigidity and the compactness that adapts it to limited space — a vital factor on machine drives.

The magnetic action which releases the brake is instantaneous and powerful. The entire mechanism is completely enclosed in an easily removable cover.

On any Elliott C-W motor, here is a brake of proven quality that you can depend upon to do its job day in and day out with true Crocker-Wheeler reliability.

ELLIOTT COMPANY
Crocker-Wheeler Division
AMPERE, N. J.

BRANCH OFFICES AND REPRESENTATIVES IN PRINCIPAL CITIES
ELLIOTT *Approved* SERVICE SHOPS COVER THE COUNTRY
General Offices & Main Plant — Jeannette, Pa.

Squirrel-cage protected type Form BA. An open drip-proof motor for general purpose use. It is available in wide modifications to meet a variety of conditions.

DC drip-proof and drip-proof-protected types. Form F, in ratings to 7½ hp. Form H, in 10 to 200 hp.

Squirrel-cage, totally-enclosed, non-ventilated Form BE. Available up to and including 3 hp at 1800 rpm, for applications requiring protection against dust, fumes, moisture and similar conditions.

Why pay for unneeded "specs" in ball bearings?

In many applications where speeds and loads are moderate, you don't need a precision bearing. When this is the case, Schatz "Commercial" Ball Bearings can cut your costs by as much as 85%—*without any sacrifice in operating efficiency.*

Why are savings like this possible? Because "Commercial" Ball Bearings are designed to wider tolerances than precision bearings...because they are available unground, partially-ground, or fully-ground. And, because, in almost all cases, cages are not used.

If you have an application where speeds and loads are moderate, it will pay you to look into Schatz "Commercial" Ball Bearings. To learn how you may save, write for literature described below.

THE SCHATZ MANUFACTURING COMPANY
6758 Fairview Avenue, Poughkeepsie, New York

Schatz "Commercial" Bearings used on these products

Dishwashers • Outboard motors
Automobile steering mechanisms
Elevators • Box machinery
Office equipment
Flexible shafts • Lawn mowers
Masonry cutting equipment
Textile machinery • Farm equipment
Laundry equipment

What about your product?

The oldest, largest manufacturer of "Commercial" ball bearings

SCHATZ
"Commercial"
BALL BEARINGS

Technical literature available:
Schatz Catalog 11 contains drawings and specifications of Schatz Ball Bearings.
Technical Bulletin tells how to determine proper type and size "Commercial" Ball Bearing for various speeds and loads.
Nylon Bearing Parts discusses advantages of nylon parts in "Commercial" bearings.

Fractured for safety

You can be sure that Federal Ball Bearings will stand up under the heaviest loads.

You see, bearing races must be heat-treated *right through to the core* if they're to have the proper degree of resilience, toughness and resistance to compression and distortion. To make sure that Federal bearing races are properly heat-treated, we use completely automatic control throughout the hardening cycle.

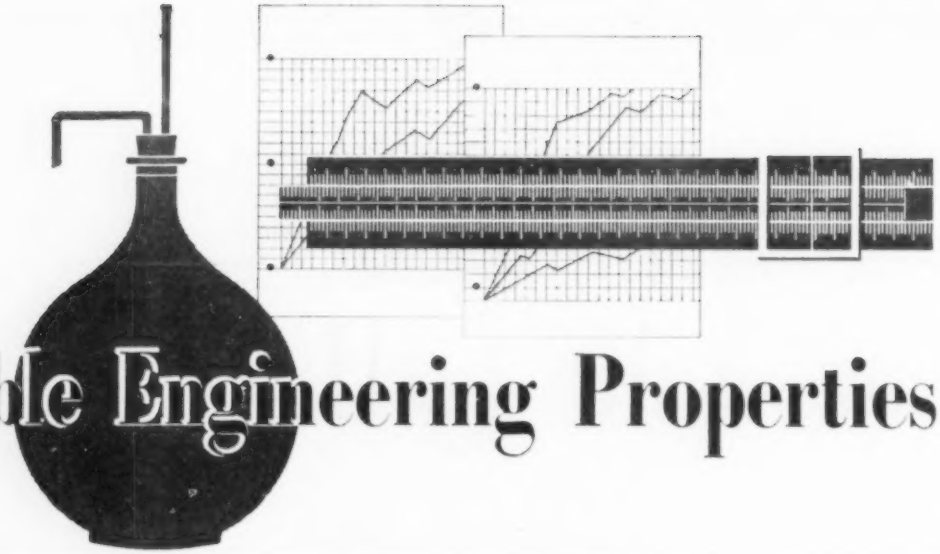
Even so, nothing's left to chance. Samples of the heat-treated races are sent to our lab. Here, they are crush-tested to measure load-bearing strength...given a hardness test. Then the fracture is examined.

A smooth fracture tells *us* all is well—and tells *you* that Federal Ball Bearings will render top-notch performance under the heaviest loads.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal
Ball Bearings

One of America's Leading Ball Bearing Manufacturers



Reliable Engineering Properties

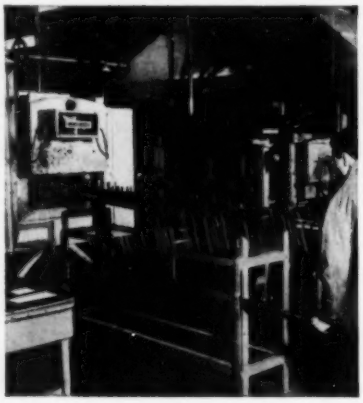
PHYSICAL CHARACTERISTICS OF PORCELAIN ENAMEL

Hardness, Impact and Abrasion Resistance

The hardness of Porcelain Enamel as measured by scratch test using Moh's scale, is between 5 and 6 for most grades. This is comparable to Brinell hardness of about 500 or a Rockwell "A" of about 70. Impact resistance varies with the type and thickness of enamel and steel.

Abrasion resistance may be measured by the loss of gloss under standard abrasion test conditions. Porcelain Enamels designed for high resistance to abrasion have an index of not less than 60. Good plate glass has an abrasion index of 50.

Heat Resistance and Emissivity



For most Porcelain Enamels, the softening temperature is 1200° F., which is about 300° F. lower than the firing temperature—approximately 1500° F. Special high temperature enamels have been recently developed to withstand 1700° F. and higher. However, the limiting temperature of most enamels is 800° F.-1000° F.

Thermal shock resistance is generally good.

Emissivity, the heat emitting value of Porcelain Enamel, is higher than almost any other material—an important advantage in heating applications.

Chemical Resistance

Porcelain Enamel can be formulated in grades which will resist attack from most chemicals, including those encountered in the food, chemical, pulp, paper, dye and petroleum industries. Those grades designated as "acid-resisting" are immune to most acids, including sulfuric and nitric, but not to hydrofluoric acid. All grades of Porcelain Enamel resist all organic solvents and are reasonably resistant to alkalies, except those containing free caustic. Special alkali resistant grades are produced for water heaters, laundry tubs and similar products.

Make PORCELAIN ENAMEL

ON STEEL

a Versatile, Modern Material

FOR YOUR PRODUCTS

ON STEEL

Weathering

The corrosion- and abrasion-resisting properties of Porcelain Enamels provide a high degree of resistance to deterioration due to weathering. In a seven-year test of various materials under severe conditions, it was found that acid-resisting Porcelain Enamels were not affected by the sun, the atmosphere, or by temperature changes.

These tests included several grades of Porcelain Enamel, and were made in a number of locations where conditions are severe.. The degree of weathering was measured by the percentage of original gloss retained.

Porcelain Enamel on Steel has expanded its use from the kitchen and bathroom into the industrial field. Wherever there is need for a strong, lightweight material that will provide resistance to corrosion, high temperatures, abrasion and chemicals, Porcelain Enamel on Steel has qualities that no other material can offer. In aircraft power plants, for example, where lightness is necessary, service is severe and unfailing performance is essential, Porcelain Enamel is beginning to play a vital role.

Modern Porcelain Enamel has much to offer the designer and manufacturer of a wide variety of products for both the consumer and the industrial markets. It is enhanced by the appeal of beauty and an almost unlimited range of non-fading colors, and it has the strength of its steel base.

Experienced, well-established firms are glad to offer technical assistance in studying the application of Porcelain Enamel to any specific product.

PORCELAIN ENAMEL INSTITUTE, INC.—Please send me complete information on Porcelain Enamel. I am interested in considering this material for the following applications:_____

NAME_____

COMPANY_____

ADDRESS_____

PORCELAIN ENAMEL INSTITUTE, INC.

1010 Vermont Avenue, N. W. Washington 5, D.C.

See what adhesives are doing today!

PHOTO COURTESY OF COLEMAN COMPANY, INC., WICHITA, KANSAS

Helping to give better heat—quietly

Making furnaces that produce heat is one thing. Making them so they operate quietly and efficiently is a little tougher.

To cut down heat loss and blower noises, most furnaces contain glass fiber insulation. However, furnace manufacturers found that conventional fastening methods were inadequate for attaching this low density material to steel panels and housings.

Then, 3M rubber-based adhesives were applied to the job. They provided a full area of contact between glass fiber and steel. The resulting bond was unaffected by operating temperatures or vibration. Furthermore, application time was cut in half!

See what adhesives can do for you . . .

This is but one of many "success stories" illustrating why progressive companies rely on 3M adhesives whenever a fastening problem is at hand. Like to have a booklet telling how you can use 3M products to cut costs and production time? Ask your 3M salesman or write today to 3M, Dept. 44, 411 Piquette Ave., Detroit 2, Michigan.

see our catalog in PRODUCT DESIGN FILE or write for copy

3M COMPANY

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ADHESIVES AND COATINGS DIVISION • 411 Piquette Ave., Detroit 2, Michigan
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MAKERS OF "SCOTCH" BRAND PRESSURE-SENSITIVE ADHESIVE TAPES • "SCOTCH" BRAND SOUND RECORDING TAPE • "SCOTCHLITE" BRAND REFLECTIVE SHEETINGS • "3M" ABRASIVE PAPER AND CLOTH • "3M" ADHESIVES AND COATINGS • "3M" ROOFING GRANULES • "3M" CHEMICALS.

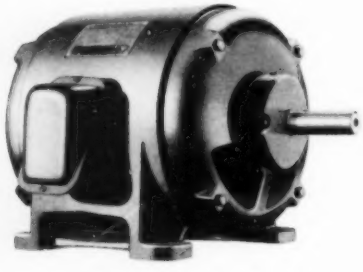
ALLIS-CHALMERS
Drives for Designers
One Reliable Source for . . .
Everything from Power Line to Driven Shaft
Control
Motor
Texrope V-belt Drive
A-4006

Designed to

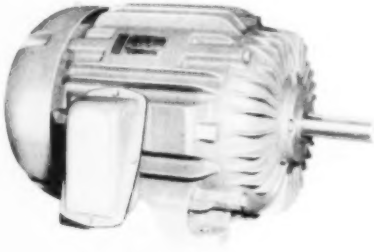
Constant speed
Texrope V-belt drive

Vari-Pitch stationary
control drive

Vari-Pitch motion
control drive



Open, drip-proof
squirrel cage motor

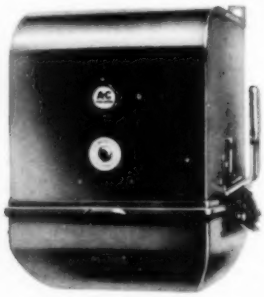


Totally-enclosed, fan-cooled
squirrel cage motor

Open, drip-proof, face-mounted
vertical squirrel cage motor

Across-the-line manual starter

Combination
starter



Reduced voltage starter

ALLIS-CHALMERS

Work Together

Texrope Drives

Texrope V-belt drives, the original multiple V-belt drive, are available in a complete range of sizes and types, both fixed and variable speed. More and more designers are finding that the moderate cost of *Vari-Pitch* sheaves is returned many times in increased machine versatility and more precise quality control. With either Stationary Control or Motion Control *Vari-Pitch* sheaves, speeds can be accurately adjusted quickly and easily over a wide range.

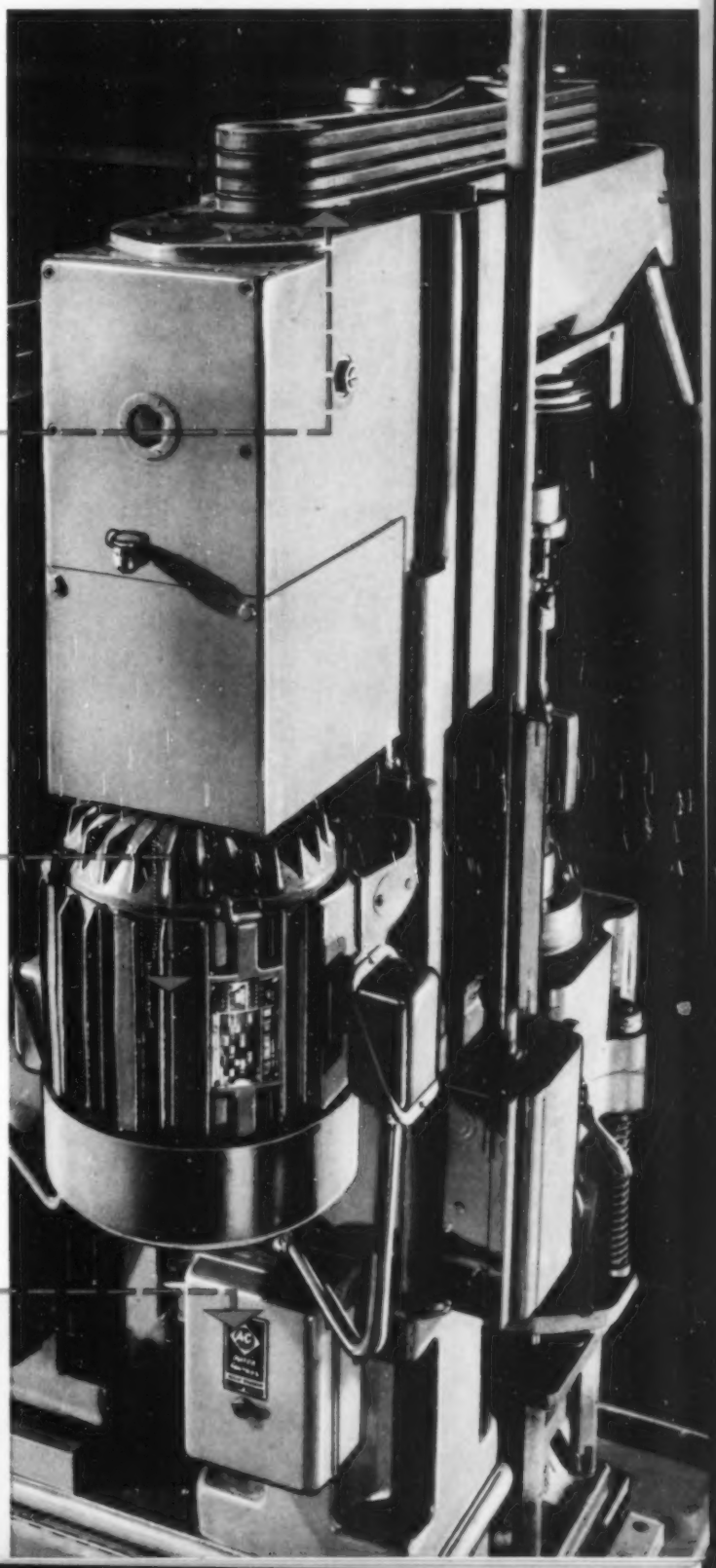
Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

Motors

Allis-Chalmers general purpose, special purpose and special design motors meet almost every designer's needs for motors from ½ hp up. Types include squirrel cage, wound rotor and dc for single or multi-speed operation. Available with a full range of torque characteristics and a wide option of enclosures and mounting methods. Special designs to meet any requirement. Shown at the right is a drilling machine equipped with a totally-enclosed, fan-cooled Allis-Chalmers motor. Reduced maintenance of the dirt-excluding fin-type design is making it very popular for machine tool applications.

Motor Control

Allis-Chalmers motor control is available for most designers' applications from size 0 up. Allis-Chalmers builds many types of squirrel cage and wound rotor motor control, dc motor control, and variable speed control for many applications. Shown here is a full voltage across-the-line starter with reset button.



A-C ALLIS-CHALMERS

Everything from Power Line to Driven Shaft

Nation Wide Service

YOUR CUSTOMERS will have no trouble getting competent service on your products when you use Allis-Chalmers motors, control and drives. There are nearly 100 Allis-Chalmers Certified Service Shops located in every industrial area in the country.

Allis-Chalmers Certified Service Shops are hand-picked independent units which have been chosen for their modern equipment, efficient methods, wide experience and business integrity. These Certified Service Shops assure your customers of factory-approved parts and service methods on Allis-Chalmers drive equipment. If you use special motors, the factory makes available to all Certified Service Shops the necessary information to assure a good service job.

ALLIS-CHALMERS

Milwaukee 1, Wisconsin

SEND THIS COUPON TODAY

Allis-Chalmers Manufacturing Company
Box 512
Milwaukee 1, Wisconsin

Please send me the literature for designers checked below.

Motors

- ☐ Handy Guide to Motor Selection 51B6052
- ☐ Squirrel Cage Motors 51B6210

Control

- ☐ Handy Guide to Starters 14B7733
- ☐ Reduced-voltage Starters 14B7215

***Texrope* Drives**

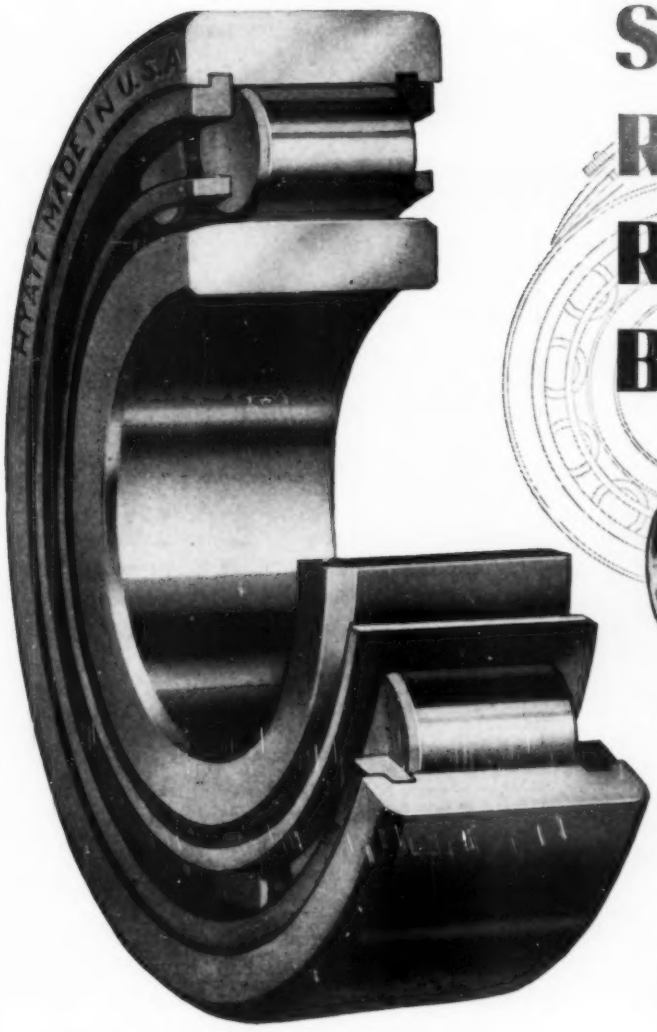
- ☐ Handy Guide to *Texrope* Drives 20B6051
- ☐ *Vari-Pitch* Drive Engineering Data 20B7499

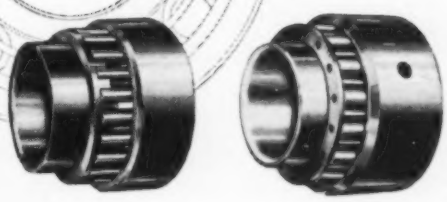
Name..... Title..... Company.....

Address..... City and State.....

Answer to a LOADed question . . . the best way to handle radial loads is with . . .

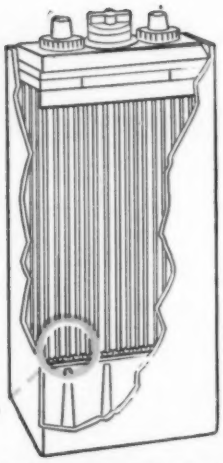
HYATT STRAIGHT RADIAL ROLLER BEARINGS



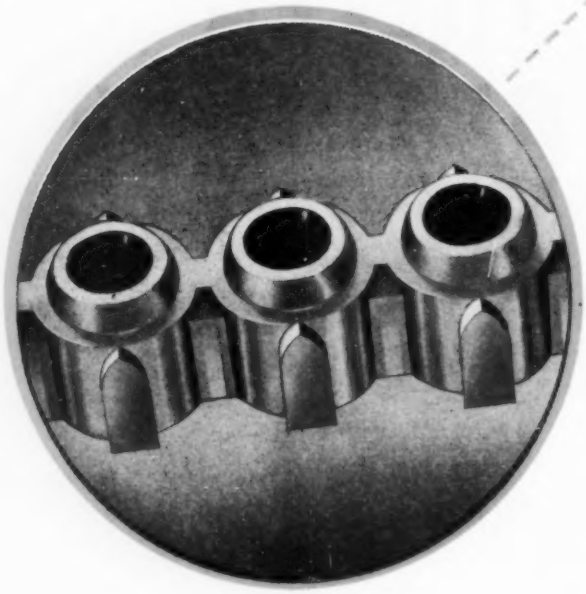


Wherever the jobs . . . and the loads . . . are big, you'll find radial roller bearings smoothing the path of power, because radial roller bearings give the greatest load-carrying capacity within given boundary dimensions. And, whenever radial loads enter the picture, design engineers naturally turn to Hyatt for the most complete line of radial roller bearings available anywhere. The wide range of Hyatt Roller Bearing sizes and types allows the engineer greater design flexibility, makes his job easier. If you are not familiar with the complete Hyatt line, write for our general catalog No. 150. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS



Battery tube sealers of acid-resistant DU PONT "ALATHON"*



Sealers molded for The Electric Storage Battery Co., Philadelphia, by Bachman Bros., Philadelphia, and Amos Molded Plastics, Edinburg, Ind.

*REG. U. S. PAT. OFF.

DU PONT

BETTER THINGS FOR BETTER LIVING
...THROUGH CHEMISTRY

Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

lengthen working life of industrial storage batteries by reducing leakage of active material

A new feature of the Exide-Ironclad industrial battery is positive-plate tube sealers made of Du Pont "Alathon" polythene resin. They reduce the previous low loss of active material by 50% . . . contribute to longer useful battery life. These permanent, non-corroding sealers also insulate the bottom of the plates . . . prevent short circuits.

This is another example of improved performance made possible by the outstanding properties of "Alathon." Its resilience insures a tight fit where the sealers cap the plates—reducing loss of active material and cushioning the plates as well. And "Alathon" is unaffected by electrolyte or electrolytic action. The intricately shaped sealers are economically mass-produced by rapid injection molding.

The excellent electrical, chemical and mechanical properties of Du Pont "Alathon" have led to its use in such varied applications as flexible tumblers, toys, squeeze bottles, and insulation for TV lead-in wire, and police and fire-alarm cable.

Perhaps Du Pont "Alathon" can help you improve or develop a product. We'll gladly suggest suppliers of molded parts or work with you in developing new applications. For full information, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department,
Room 104 A, Du Pont Building
Wilmington 98, Delaware

BUILT-IN

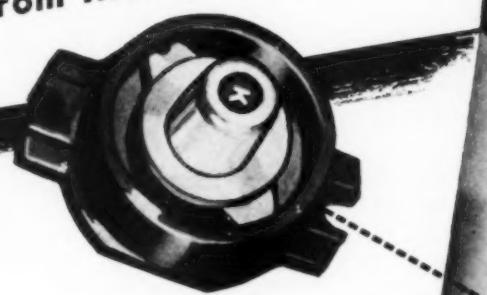
KLIXON

MOTOR PROTECTOR

Safe Guards

"IN-SINK-ERATOR"

from Motor Burnouts



"In-Sink-Erator" food waste disposer eliminates one of the messy kitchen problems faced by the housewife by having the garbage go down the drain. It is easily installed in sinks, safe to use.

One of the first garbage grinder manufacturers to use Klixon Protectors, In-Sink-Erator Mfg. Company, has used Klixon Manual Reset protectors in their disposer since 1946. The reason — experience proves that these protectors can be depended on to provide protection against motor burnouts, thus assuring trouble-free operation for years on end.

You, too, can keep your motors operating longer, reduce service calls and repairs by specifying and using Klixon protected motors. The additional cost is exceptionally low, pays for itself in customer goodwill by reducing motor burnouts.

KLIXON *Thermo Snap* TEMPERATURE CONTROLS

Actuated by the snap-acting Spencer Disc, these controls open the circuit with a quick, clean break; close with a solid make. Their accurate operation withstands shock, vibration, motion and altitude. Used in military and commercial applications ranging from tanks, aircraft, sterilizers, radio and electronic equipment to household appliances. Available in many types and ratings including hermetically sealed units.

KLIXON

SPENCER THERMOSTAT

Division of Metals & Controls Corporation

904 FOREST STREET, ATTLEBORO, MASS.

What do YOU make that takes wire?

If you make sieves or staples, screws or screens—whatever you make that takes wire—we're pretty sure to have the kind of manufacturers wire you need. Round, flat, square . . . hard, soft, ductile . . . plain, tinned, or bright finished . . . carbon, alloy, or stainless. Altogether we produce over 400 different types of wire which are suitable for practically all everyday wire applications.

But, if you need a special kind of wire, we can supply that too. Our modern plant facilities enable us to draw wire to meet the exact specifications of a special order, and our trained metallurgists are always ready to assist you with any manufacturing problems you may have.

We've been in the wire-making business more than one hundred years, and all of our experience is at *your* service . . . to help you do an easier and better fabrication job.

If you make it of wire... make it of the best!

U·S·S AMERICAN MANUFACTURERS WIRE

AMERICAN MANUFACTURERS WIRE

AMERFINE—*High-quality fine wire.*

AMERSPRING—*music steel spring wire.*

AMERLOY—*alloy heading wire.*

AMERTEMP—*heavy-duty oil-tempered wire.*

AMERHEAD—*uniform heading wire.*

AMERSTITCH—*extra-tough metal stitching wire.*

USS

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION, GENERAL OFFICES: CLEVELAND, OHIO

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TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA., SOUTHERN DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

MODERN DESIGNS BENEFIT FROM THE NEWS IN PLASTICS

Raw materials and molding techniques have wrought changes in design and production

Four, three, even two years ago many of the products on the market today would have been impossible to make in their present form.

Working with plastics, the nation's leading industrial designers and engineers have been able to transcend the design and production limitations of more traditional materials to produce large units that are not only *soundly engineered* for improved performance . . . but geared for *faster, more economical* production as well.

Radio and TV cabinets, refrigerator shells, unit air conditioner housings, and furniture are only a few of the products now being molded of plastics in *one* piece . . . with machining, assembly, finishing operations eliminated or materially reduced. Here, too, plastics add other pluses: clean, attractive appearance . . . light weight . . . durability . . . resistance to water, acids, alkalies, heat, and rust . . . and many other advantages.

For more information, you are invited to send for Monsanto's new management report which includes a study of how plastics are geared for volume production of large parts today. The coupon is for your convenience. For individual assistance with your problem, call on the Monsanto Technical Council—a board of experts in plastics at your command.

FREE—
Send for your Materials-Trend Report today. Mail the handy coupon

MONSANTO CHEMICAL COMPANY, Plastics Division, Room 2128
Springfield 2, Mass.

Please send me your new report on the latest materials-trend.

Name & Title _____

Company _____

Address _____

City, Zone, State _____

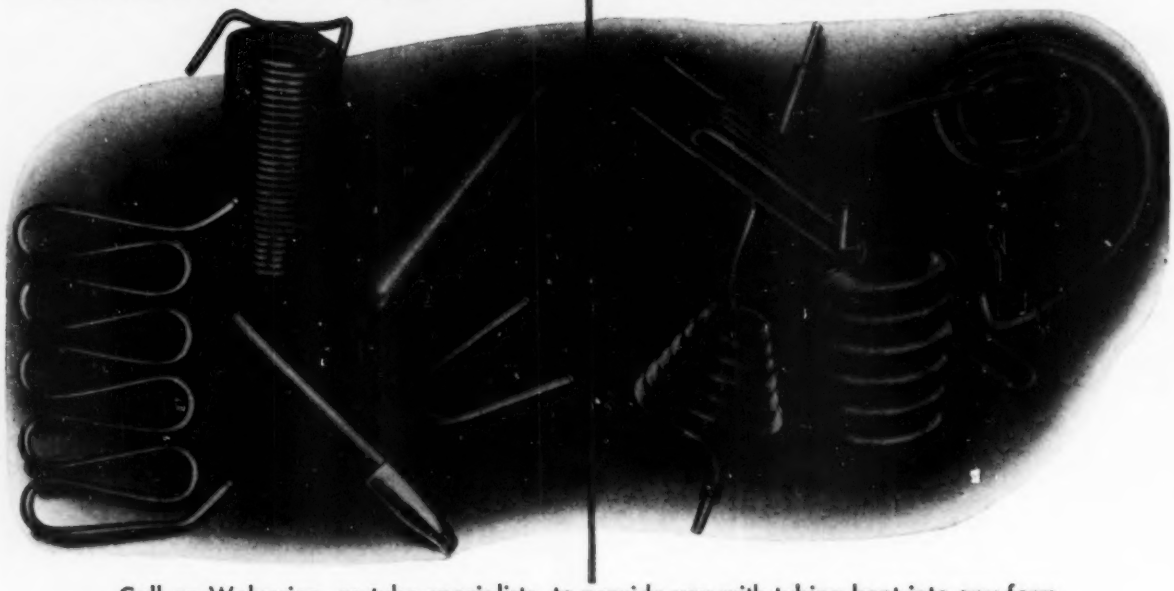
MONSANTO
CHEMICALS AND PLASTICS

SERVING INDUSTRY...WHICH SERVES MANKIND

WOLVERINE will supply you with nonferrous tube fabricated in a variety of forms

Like this . . .
IN PLAIN TUBE

Like this . . .
IN FINNED TUBE



Call on Wolverine, as tube specialists, to provide you with tubing bent into any form that will best meet your particular requirements. Illustrated above are only a few typical forms.

Whether you require a simple bend, a closely wound coil or a more complex one — whether in plain tube or in the unique Wolverine Trufin* (the integral finned tube), it can be provided by Wolverine to your complete satisfaction.

Think of Wolverine first when you think of tube in any form — straight lengths or fabricated. Our Customer Engineering Service will be glad to help you in selecting the proper tube and tubular form. Send for our booklet, Fabricated Tubular Parts.

★REG. U. S. PAT. OFF.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ontario.

Other Wolverine Products

CAPILATOR*
—the capillary tube for restriction purposes
COMMERCIAL TUBE
AUTOMOTIVE TUBE
CONDENSER TUBE
COPPER WATER TUBE (K-L-M)
ELECTRIC WELDED STEEL TUBE
FABRICATED TUBULAR PARTS
WOLVERINE TRUFIN*
—the integral finned tube
REFRIGERATION AND AIR CONDITIONING TUBE (Plain or Tin Plated)
S.P.S. PIPE
SPUN-END TUBE†

*Reg. U.S. Pat. Off.
† A Patented Process RE 22465

WOLVERINE TUBE DIVISION
of CALUMET & HECLA, INC.
Manufacturers of Tubing Exclusively
1415 CENTRAL AVENUE • DETROIT 9, MICHIGAN

ESTABLISHED 1916

Plants in Detroit, Mich. & Decatur, Ala. *Sales offices in Principal Cities*

Export Department, 13 E. 40th St., New York 16, N. Y.

In spots like this your portable tools need G-E Geoprene Cord

Tough . . . oil-resistant . . . built for hard use

Here is the cord designed to match the performance of your heavy-duty, portable electrical equipment. Grease, oils, acids, or other rubber solvents won't harm G-E Type SO Geoprene cord. Neither will sunlight, flame, or water. It's built for hard use. Stranded, 2, 3, or 4 conductors, capacity to 20 amp, rated 60 C, 600 volts. U.L. listed.

On your assembly line

Tinned-copper conductors facilitate connections on G-E Type SO Geoprene cord. The insulation strips cleanly—the jacket holds wrap and fillers firmly in place. For your heavy-duty equipment you'll get economical assembly with G-E Type SO Geoprene cords. For more information, write Section W61-467, Construction Materials Division, General Electric Company, Bridgeport 2, Connecticut.

*Registered Trade-mark General Electric Company

1878 75 1953 YEARS OF ELECTRICAL PROGRESS

You can put your confidence in—

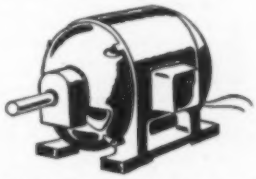
GENERAL ELECTRIC

WIRE AND CABLE IDEAS for Product Designers

Machine Tool Wire: G-E Flamenol* machine tool wire has many advantages for the control wiring on machine tools. It is permanently color coded for easy circuit tracing and has a small over-all diameter for use in limited space. Flamenol wire is not affected by lubricating or cutting oils, acids, or alkalies.

Deltabeston Wire: Where extreme heat or corrosive vapors are present, you'll get dependable service with G-E Deltabeston* wires. They come in many types for use as appliance lead, ground, or hinge wires, as stove and range wires, as permanent wave machine wire.

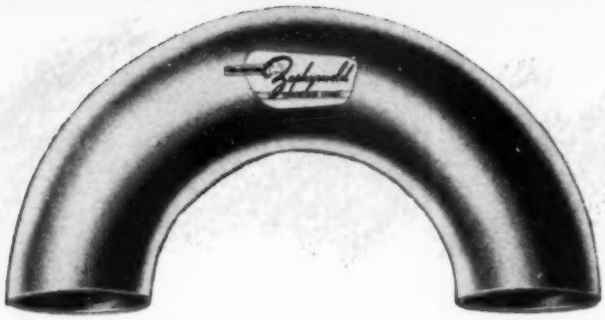
Handy Booklet: 24-page booklet for product designers. Contains charts, specifications, applications for the standard line of G-E wires, cables, and cords. For daily reference. Write for your copy.



Small Motor Leads: For coils, transformers, motors, or ballasts you'll get excellent service with G-E Type F small-motor leads. Listed by Underwriters' Laboratories, Inc.

. . . here is the *MARK OF QUALITY*

Try TRI-CLOVER



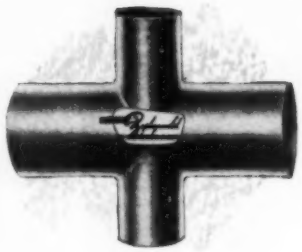
ZEPHYRWELD® WELDING FITTINGS

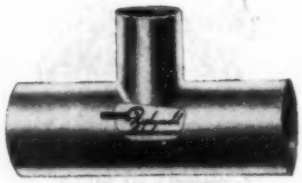
● TRI-CLOVER offers the most complete line of *Zephyrweld* Schedule 5 and 10 stainless steel welding fittings in sizes from ½" through 24" and 36" for use with stainless steel light gauge pipe. In addition, Schedule 40 fittings are available in sizes through 24".

These porosity-free fittings are fabricated from stainless steel types 304, 347, 316 and other stainless steel analyses . . and are annealed, pickled and passivated in sizes through 4". Larger sizes are passivated and may be annealed upon request.

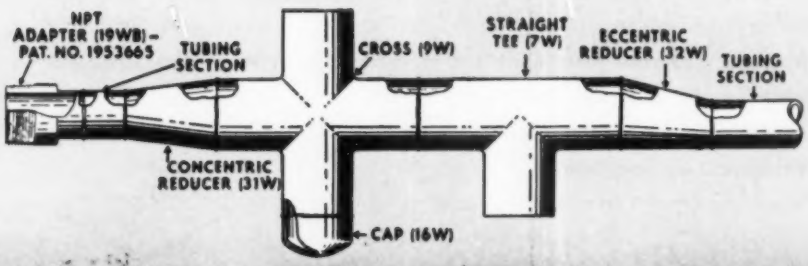
Schedule 5 and 10 fitting ends are cut flush for rapid welding. Because of their light gauge, no chamfering is required. Schedule 40 fittings are beveled in accordance with ASA specifications.

In addition to butt welding pipe fittings, Tri-Clover manufactures a complete line of stainless steel tube O.D. butt welding fittings for use with light gauge tubing.





● Shown at the right is a composite drawing showing the way in which Zephyrweld fittings are assembled, by butt welding, to light gauge pipe, or to one another. All ends are square and true—no chamfering is required to accomplish fast, clean welding. Note how Zephyrweld fittings are adapted to iron pipe size fittings through use of a special adapter.



See your nearest TRI-CLOVER DISTRIBUTOR for details

. . . or write for literature on the products in which you are interested.

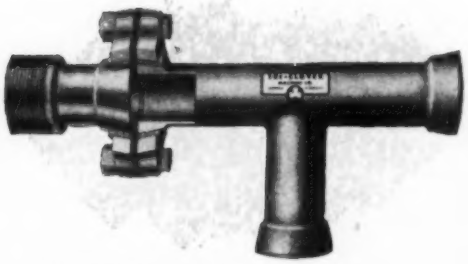
on Stainless Steel Fittings for Chemical-Process Service

TRI-CLOVER offers over 30 years of specialized experience in solving corrosion-resistant piping problems. Skilled craftsmen and engineers have made the name *Tri-Clover* the mark of *quality* on stainless steel and alloy fittings, valves, pumps and specialties.

Your selection of the *right* fitting, valve, pump, tubing or pipe for any specific application is made easier by Tri-Clover's complete production and engineering facilities. Benefit from this fact. For here is one dependable source . . . one responsibility for your chemical-process piping and pumping problems.

Our experienced engineering service is at your disposal to help solve your specific corrosion-resistant piping problems.

Remember to specify Tri-Clover.



CONICAL END FITTINGS

A complete line of ells, tees, crosses, laterals, reducers, etc., fabricated in Stainless Steel Type 316 and other SS analyses. Available in sizes from 1" O.D. through 4" O.D. A lightweight, low cost installation that is simple, fast and leak tight. Fully annealed, pickled and passivated.

RECESSED END FITTINGS for SOLDERING, BRAZING or SOCKET WELDING

Low cost, lightweight, high quality fittings designed for fast, simple soldering, brazing or socket welding. Fabricated in Stainless Steel Types 304, 347 and 316. Full line of elbows, return bends, tees, crosses, adapters, etc., in sizes from ¾" through 24". Available in pickled or polished finish with any combination of I.D. or O.D. finish required. All fittings fully annealed and passivated.

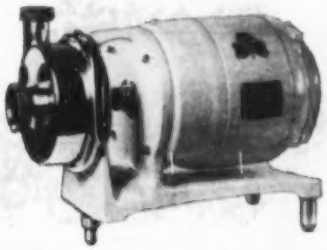
SANITARY FITTINGS

Tri-Clover "sanitary" type stainless steel fittings are available in sizes from 1" through 4" O.D., in a full range of fitting types, including those designated and approved as meeting 3A Standards throughout. These modern fittings incorporate numerous exclusive design and construction features that assure highest quality.

Tri-Clover sanitary fittings are widely used in processing foods and pharmaceuticals.

STAINLESS STEEL TUBING and PIPE

A full line of stainless steel tubing and pipe is available for all corrosion-resistant needs in sizes from 1" through 42" O.D.



TRI-CLOVER PUMPS . . . Tri-Clover Centrifugal Pumps are available in a complete range of sizes and capacities up to 1250 GPM and up to 250 ft. head at zero GPM. Fast, non-clogging centrifugal action with special seals for practically every requirement. Fabricated of highest quality, corrosion-resistant metals.

CUSTOM FABRICATION . . . Tri-Clover is fully equipped to furnish even the most complex custom fabricating jobs, right from the blueprint stage. Write for full details.

Tri-Clover
MACHINE CO.
Kenosha, Wisconsin

TRIALLOY AND STAINLESS STEEL SANITARY FITTINGS, VALVES, PUMPS, TUBING, SPECIALTIES

FABRICATED STAINLESS STEEL INDUSTRIAL FITTINGS AND INDUSTRIAL PUMPS

THE Complete LINE

I-153

What's Screwy? by Phillips

"Ed has discovered that Phillips Cross-Recessed-Head Screws are definitely decorative."

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

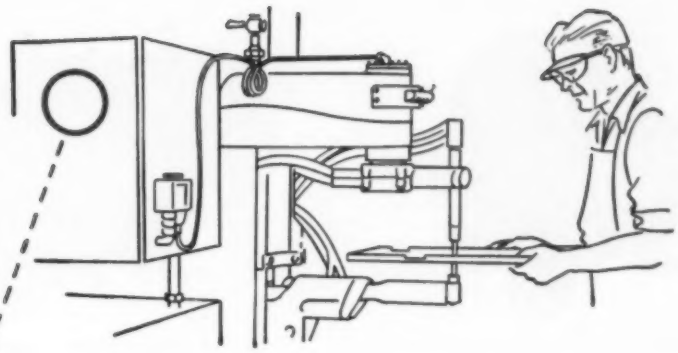
DECORATIVE APPEARANCE is but one of many advantages of Phillips Screws. They cut driving time up to 50%, eliminate driver skids and split screw heads. These screws add structural strength, set up tighter, resist vibration. To save time, work, money insist on Phillips Screws — Wood, Machine, Tapping Screws or "Sems."

PHILLIPS *Cross-Recessed-Head* **SCREWS**

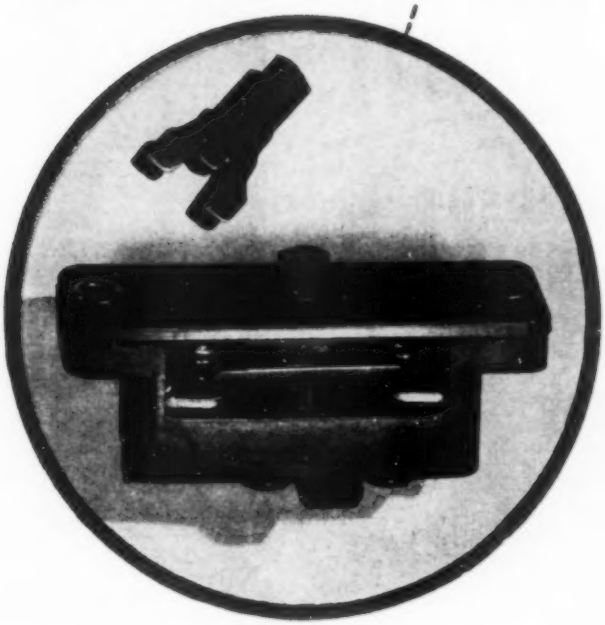
X marks the spot... the mark of extra quality

AMERICAN SCREW COMPANY • ATLANTIC SCREW WORKS, INC. • THE BLAKE & JOHNSON CO.
CENTRAL SCREW COMPANY • CONTINENTAL SCREW COMPANY • THE EAGLE LOCK COMPANY
ELCO TOOL AND SCREW CORPORATION • GREAT LAKES SCREW CORPORATION • THE H. M. HARPER CO.
THE LAMSON & SESSIONS COMPANY • NATIONAL LOCK COMPANY
THE NATIONAL SCREW & MANUFACTURING CO. • PARKER-KALON CORPORATION
PHEOLL MANUFACTURING CO. • ROCKFORD SCREW PRODUCTS CO. • SCOVILL MANUFACTURING CO.
SHAKEPROOF DIV. OF ILLINOIS TOOL WORKS • THE SOUTHINGTON HDWE. MFG. COMPANY
STERLING BOLT COMPANY • STRONGHOLD SCREW PRODUCTS, INC. • WALES-BEECH CORP.

TODAY'S...AND THE FUTURE'S...FINEST FASTENER



Improved switch performance with Du Pont nylon plastic



Button molded by
Gries Reproducer Corp,, New York, N.Y.
for
Square D Company, Milwaukee, Wisc.

Molded part increases electrical clearance and service life of snap switch . . . cuts costs

Precision snap switches are used as limit controls in small machine tools and as basic contact mechanisms in industrial instruments. In timing relays on resistance welding machines, for example, they control the duration of current flow and electrode motion. Two key parts affecting the switch's performance are the operating button and stem. They require accurate dimensions that must stand up under severe wear.

For their switches, the Square D Company specified that the button and stem be molded in one piece from Du Pont nylon plastic. Tough, resilient Du Pont nylon resists abrasion. Critical dimensions are maintained. Nylon can be molded to close tolerances for finer dimension control and improved operation. The superior insulating properties of nylon increase electrical clearances . . . permit extended Underwriters' Laboratories listing. According to Square D Company: "The nylon part gives more accurate trip characteristics, longer service life and increased electrical clearance." Nylon's light weight and strength in thin sections mean mass production by rapid injection molding at low cost per unit. This nylon part costs 60% less than the former two-piece assembly.

This is another example of where Du Pont nylon plastic serves industry as a superior engineering material. Perhaps it can be of value to you. For full information on nylon and other Du Pont plastics, write: E. I. du Pont de Nemours & Co., (Inc.), Polychemicals Department, Room 104, Du Pont Bldg., Wilmington 98, Delaware.

DU PONT
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BETTER THINGS FOR BETTER LIVING
. . . THROUGH CHEMISTRY
Polychemicals
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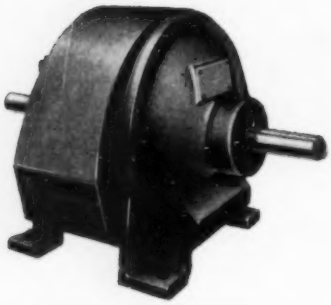
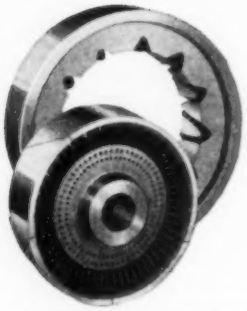
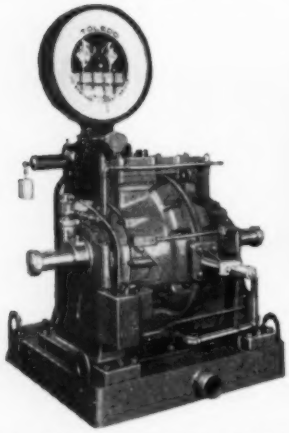


AIR COOLED COUPLINGS

AJUSTO-SPEDE MOTORS



AIR COOLED BRAKES



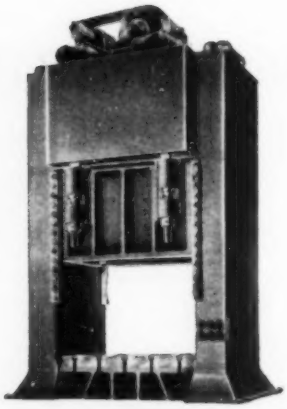
ABSORPTION DYNAMOMETERS

EATON

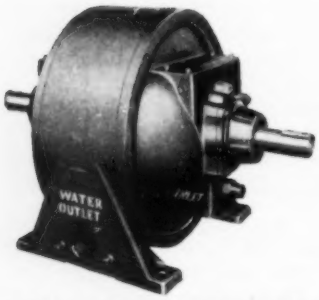
DYNAMATIC

®

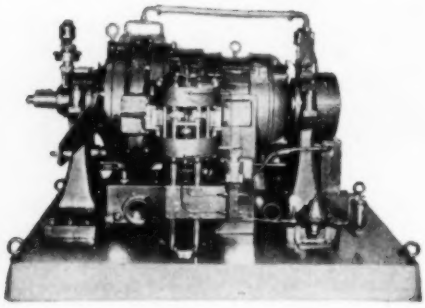
EDDY-CURRENT ROTATING EQUIPMENT



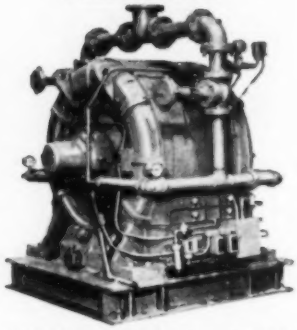
PRESS DRIVES



LIQUID COOLED COUPLINGS



UNIVERSAL DYNAMOMETERS



LIQUID COOLED BRAKES

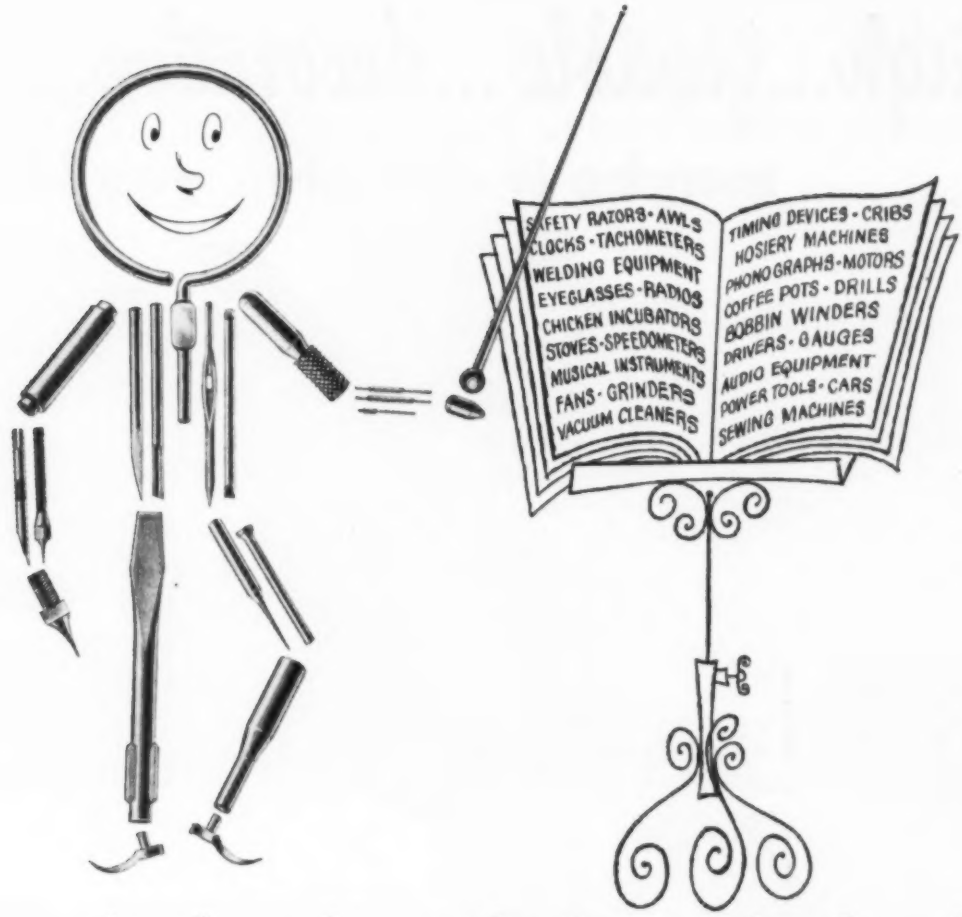
Dynamatic Eddy-Current electro-magnetic equipment represents the ideal solution for a wide range of adjustable-speed drive problems, particularly where an AC power source is a requirement. Typical applications include paper machine drives, cement mill drives, industrial truck clutches, press drives, crane brakes, fan drives—in fact, practically all test, processing, and conveying equipment common to industry. Instantaneous response and accurate control are important advantages.

Write for your copy of Bulletin GB-1 which describes and illustrates the basic Dynamatic units.

DYNAMATIC®

CORPORATION KENOSHA • WISCONSIN

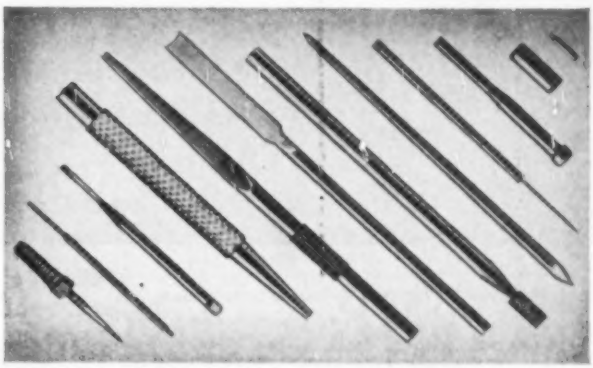
Subsidiary of **EATON MANUFACTURING COMPANY,** Cleveland, Ohio



Thousands of small parts for thousands of products

TORRINGTON MAKES THEM BETTER, AND FOR LESS!

If your product uses small precision metal parts... pivots, pins, dowels, rollers, mandrels, needles, punches... let TORRINGTON make them for you. Whether you need a thousand or a million, our position as a leading contract fabricator of small precision metal parts assures you fine workmanship, prompt delivery, low prices.



Send for your free copy of Condensed Catalog, showing many other parts that we can produce to close tolerances quickly and economically.

THE TORRINGTON COMPANY
Specialties Division
230 Field Street, Torrington, Conn.
Makers of
TORRINGTON NEEDLE BEARINGS

Tough...flexible...decorative...

maybe it can give you ideas!

THE material you see above is braided wire. Here at National-Standard it is produced in almost limitless variations . . . flat, tubular, plain, beamed, springlike or untempered, tight or expanded, in many wire sizes, in a great many widths, and of any metal that can be drawn into wire.

At present, the most common uses are for reinforcing pneumatic tire beads, high pressure hose and other rubber products. In these applications its strength and mechanical adhesion qualities are unsurpassed.

Considering its limitless variations and unique qualities, braided wire is bound to have many other effective applications. Perhaps it can save or make money for you! An interesting possibility, for example, is its use with transparent plastics to produce pleasing patterns as well as reinforcement.

If all this gives you an idea you'd like to explore, be assured that National-Standard, as usual, is ready to cooperate with you all the way. Let's talk it over. Just get in touch with the *National-Standard Company, Niles, Michigan.*

NS
NATIONAL-STANDARD
NILES, MICHIGAN

DIVISIONS OF NATIONAL-STANDARD CO.

ATHENIA STEEL	*Clifton, N. J.*	**Flat, High Carbon, Cold Rolled Spring Steel**
NATIONAL-STANDARD	*Niles, Mich.*	**Tire Wire, Stainless, Fabricated Braids and Tape**
REYNOLDS WIRE	*Dixon, Illinois*	**Industrial Wire Cloth**
WAGNER LITHO MACHINERY	*Jersey City, N. J.*	**Metal Decorating Equipment**
WORCESTER WIRE WORKS	*Worcester, Mass.*	**Round and Shaped Steel Wire, Small Sizes**

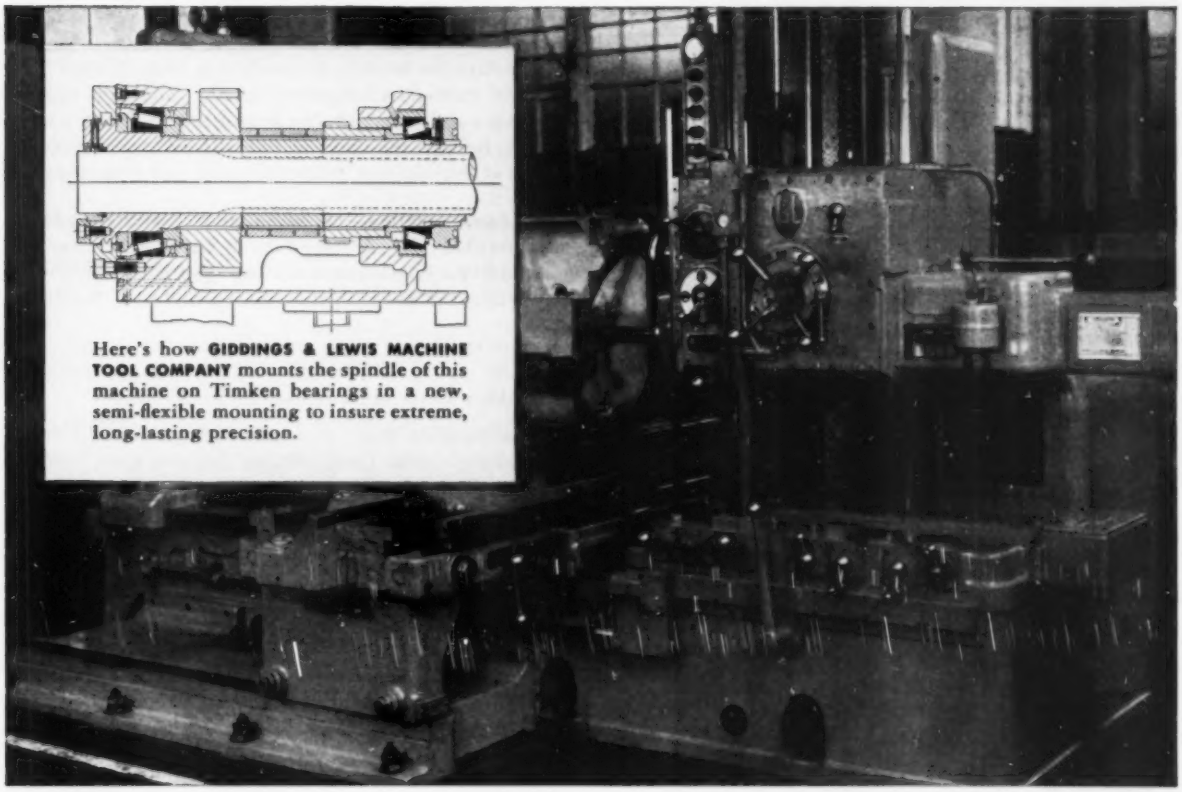
Gets high-speed spindle accuracy with TIMKEN® bearings in new semi-flexible mounting

TO insure high-speed spindle accuracy under varying conditions of speed, temperature and loading, Giddings and Lewis mounts the spindle of its 300 horizontal boring, drilling and milling machine on Timken® precision bearings in a new semi-flexible mounting.

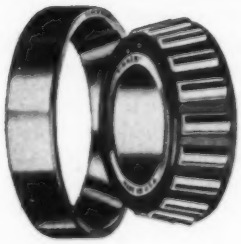
The new semi-flexible mounting was developed by engineers of The Timken Roller Bearing Company specifically to meet the requirements of higher spindle speeds. In this new mounting, the rear spindle bearing is mounted in a carrier, one end of which has a slight clearance in the housing while the other end has a tight fit (see diagram). The clearance between carrier and housing permits radial expansion to take place without excessive preloading of the bearings. The result is uniformly high spindle precision from the beginning to the end of every job.

The new semi-flexible mounting has been thoroughly proved in tests and in machine tools now in operation. For full information, write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



Here's how **GIDDINGS & LEWIS MACHINE TOOL COMPANY** mounts the spindle of this machine on Timken bearings in a new, semi-flexible mounting to insure extreme, long-lasting precision.



TIMKEN

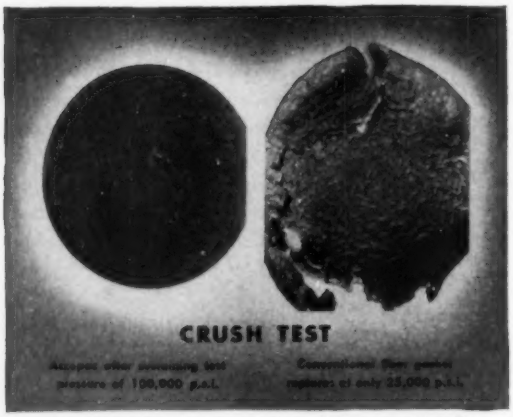
TAPERED ROLLER BEARINGS

MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!

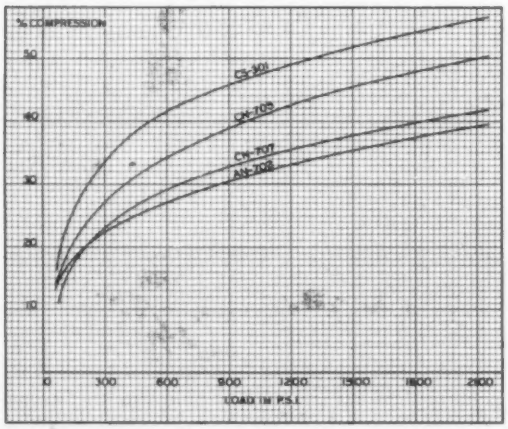
Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

NOT JUST A BALL ◯ NOT JUST A ROLLER ▭ THE TIMKEN TAPERED ROLLER ▭ BEARING TAKES RADIAL ◫ AND THRUST ⟷ LOADS OR ANY COMBINATION ✳

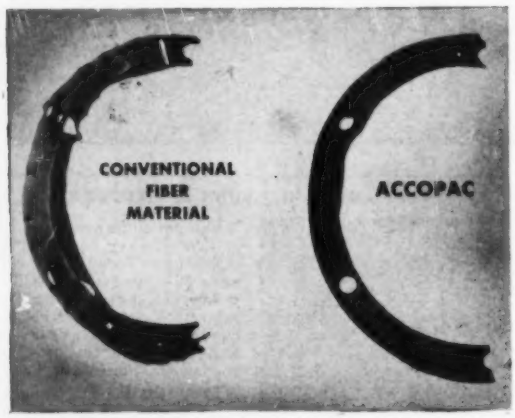
NEW ACCOPAC SOLVES



CRUSH RESISTANCE is important on light as well as heavy flanges. Even on relatively light joints, high spots or lack of parallelism can concentrate much of the available bolting pressure on small areas of the gasket.



HIGH COMPRESSIBILITY of Accopac is shown by load-compression curves. With light or stamped metal flanges, this compressibility allows gaskets to conform to surface irregularities and seal without distorting the flange.



WON'T SHRINK OR DRY OUT. After 6 months in a gear pump circulating hot oil, the conventional gasket lost its glycerine content, dried out, and leaked. Accopac gasket was virtually unaffected, still provided a good seal.

Unique fiber material combines compressibility, crush resistance, imperviousness, dimensional stability

Armstrong's Accopac® is an entirely new kind of fiber gasket material. As illustrated by the case histories on the opposite page, Accopac does sealing jobs formerly considered beyond the capabilities of fiber materials.

Composition. Accopac is made by combining finely ground cork with fiber and rubber. An improved beater saturation process covers each fiber and cork particle completely and evenly with a latex saturant. Because the fibers are literally "locked in rubber," gaskets made of Accopac are uniformly strong and impervious.

Cork adds compressibility. Accopac's cork particles make it highly compressible. This is important in lightweight constructions where Accopac gives a leak-free seal and conforms to normal irregularities without distorting flanges between the bolts.

Amazing crush resistance. Repeated tests show that Accopac can withstand loads up to 100,000 psi. without damage, although conventional fiber sheets often rupture under 25,000 psi.

Crushing is possible under the extreme high pressure often found at local high spots along a flange. Accopac gives you unequalled protection against leaks caused by crushing.

Won't shrink, won't grow. Accopac has unusual dimensional stability. Its saturants are non-volatile and non-extractable and cannot be leached out by fluid action. An Accopac gasket won't shrink, dry out, and leak in a recommended application.

In addition, Accopac suffers no permanent or progressive dimensional change through variations in humidity. Even after months of storage, an Accopac replacement gasket will still fit and seal perfectly.

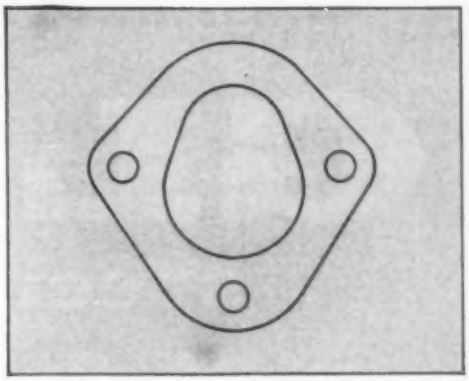
Proved in service. Even though it has been on the market a relatively short time, Accopac has already been proved in many varied applications. It has been especially useful in replacing unsatisfactory conventional fiber materials and also frequently reduces costs by replacing more expensive materials.

Both asbestos and cellulose types are available in sheets, rolls, ribbons, or die-cut shapes. The unusual flexibility of asbestos Accopac means easier cutting and less breakage.

Get samples and more information. If you cut or use gaskets, make your own tests with Accopac. For samples and more information, call your Armstrong representative or write Armstrong Cork Company, Gaskets and Packings Department, 6204 Arch Street, Lancaster, Pennsylvania.

GASKET PROBLEMS . . .

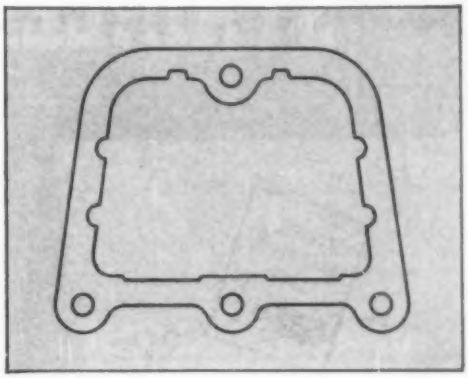
Here are three interesting applications of Armstrong's new fiber gasket material



APPLICATION: Gasket between fuel pump and cylinder block of internal combustion engine

PROBLEM: Treated paper gaskets were formerly used in this automobile engine. They performed satisfactorily in tests, but often dried out and leaked in actual use, resulting in angry complaints from customers.

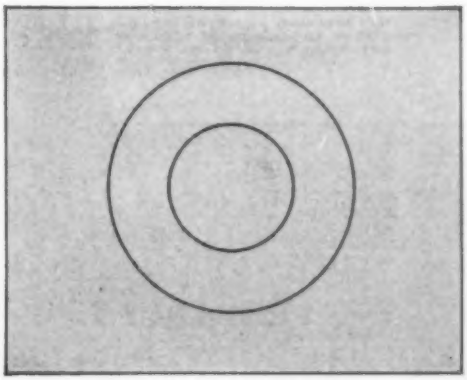
SOLUTION: Accopac CN-705 eliminated the leaks—and the complaints. Neither the action of fluids nor the heat of the cylinder block affects Accopac adversely. Accopac won't dry out and leak because its saturants are non-volatile and non-extractable.



APPLICATION: Wringer head gasket on washing machine

PROBLEM: This gasket seals grease in the wringer gear housing. The flanges are aluminum, and flange loads are relatively light. In a cost-reduction program, Accopac was tried as a possible substitute for the more expensive gasket material then in use.

SOLUTION: $\frac{1}{64}$" Accopac CS-301 does this sealing job just as well as the more expensive material. Accopac's combination of high compressibility and imperviousness gives a tight seal even under the low flange pressure involved here.



APPLICATION: Lever control washer on refrigeration compressor control valves

PROBLEM: When conventional plant fiber gaskets were used, their glue-glycerine binder attracted moisture from the air and helped corrode the control valve's aluminum and steel components.

SOLUTION: This washer is now made of $\frac{1}{32}$" Accopac CN-705. Corrosion has been completely eliminated. Accopac's latex binder is not only non-corrosive, and non-extractable, but also non-hygroscopic. The effects of humidity changes are held to a minimum giving Accopac its good dimensional stability. Replacement gaskets made from Accopac can be stored for months without deterioration or permanent dimensional change.

ARMSTRONG'S ACCOPAC

GLOBE Seamless
GLOWELD Welded

- **Resistance to Corrosion**
- **Strength at High Temperatures**
- **Resistance to Oxidation at High Temperatures**
- **Ease of Fabrication**

TYPICAL ANALYSES AND TYPES:

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302B	309Cb	317	347	430
304	310	321	403	443
308	314	329	405	446
309	316	INCONEL * — NICHROME **		

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Write for Bulletin 333 — Corrosion and Heat Resisting Steel Analyses Chart — a valuable reference tabulation of stainless steel analyses as produced by various manufacturers.

Piercing, rolling and reduction of seamless tubes is closely monitored from this control room — typical of the highly specialized equipment in the Globe mill.

SIZE RANGE:

Globe seamless stainless steel tubing may be had in sizes from ½ inch to 6 inches O.D., and in pipe sizes ⅛ inch to 6 inches, standard, extra strong and double extra strong weights.

Gloweld electric welded stainless steel tubing is available in sizes ranging from ¼ inch to 5 inches O.D. inclusive; in standard weight pipe (schedule 40) sizes ⅛ inch to 2 inches — lightweight pipe (schedule 5 and 10) ⅛ inch to 4½ inches inclusive.

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All stainless tubing furnished to standard A.S.T.M. specifications unless otherwise specified to suit your particular application requirements.

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Precision checks — and re-checks — at every stage of production insure Globe stainless steel tubes that meet *your* exacting specifications. For more than thirty years, specialization in production of steel tubes has key-noted all Globe research, engineering and mill operations. Write for the Globe Stainless Steel Tubes catalog.

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Producers of Globe seamless stainless steel tubes — Gloweld welded stainless steel tubes — alloy — carbon seamless steel tubes — Globeiron (high purity ingot-iron) seamless tubes — Globe welding fittings.

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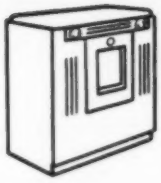
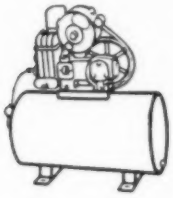
Do you know the H.P. needed for these products?



CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

Check! Practically all of today's top-notch clothes dryers use one-third h.p. motors. But did you know that many clothes dryers are powered by Delco Motors? It's true . . . manufacturers of home appliances count on Delco dependability.



CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/2-h.p. ( ) 3/4-h.p.

Yes . . . all the above horsepower ratings are in use on water pumps . . . and Delco manufactures motors with each of these ratings. For use on rotary and reciprocating pumps. That's one reason why so many makers of pumps call on Delco for every motor need.

CHECK ONE: ( ) 1/6-h.p. ( ) 1/4-h.p. ( ) 1/3-h.p. ( ) 1/2-h.p.

You win again. The vast majority of disposal units sold today are powered by one-third h.p. motors. One-third h.p. Delco Motors, that is! Disposal unit makers know from experience how Delco Motors stand up on the job . . . provide satisfying, trouble-free service through the years.

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who fall back to sleep

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Sleep through the soft morning music of your clock-radio *just once*, and you'll see an important reason to specify Telechron Timers with signal alarm for your new models. And you'll see, too, how this exclusive feature can help your clock-radio become a sales success.

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For any clock-radio price class, there's a Telechron Timer that will meet your needs. We custom style to meet your design requirements. Write for details. Telechron Department, General Electric Company, 14 Homer Ave., Ashland, Mass.

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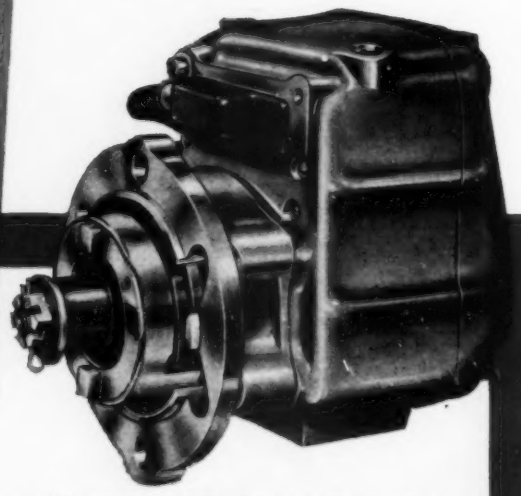

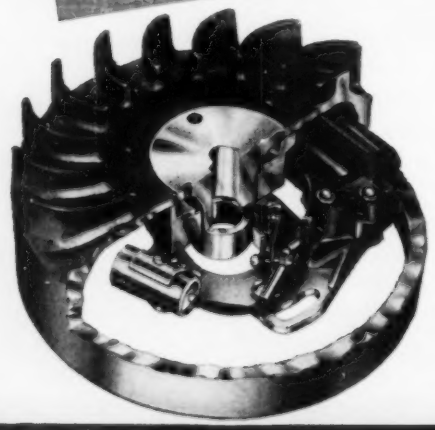

Magneto efficiency plays a mighty important part in small engine performance. So it is just good business to see that the engines you purchase are equipped with Bendix magnetos—the recognized leader for dependable starting, economy of operation, long life and freedom from breakdowns. These rugged lightweight magnetos are your best choice for their basic design assures quality performance for every type of small engine and every pricing requirement. Be sure to specify Bendix—the most trusted name in magnetos. Complete information available on request.

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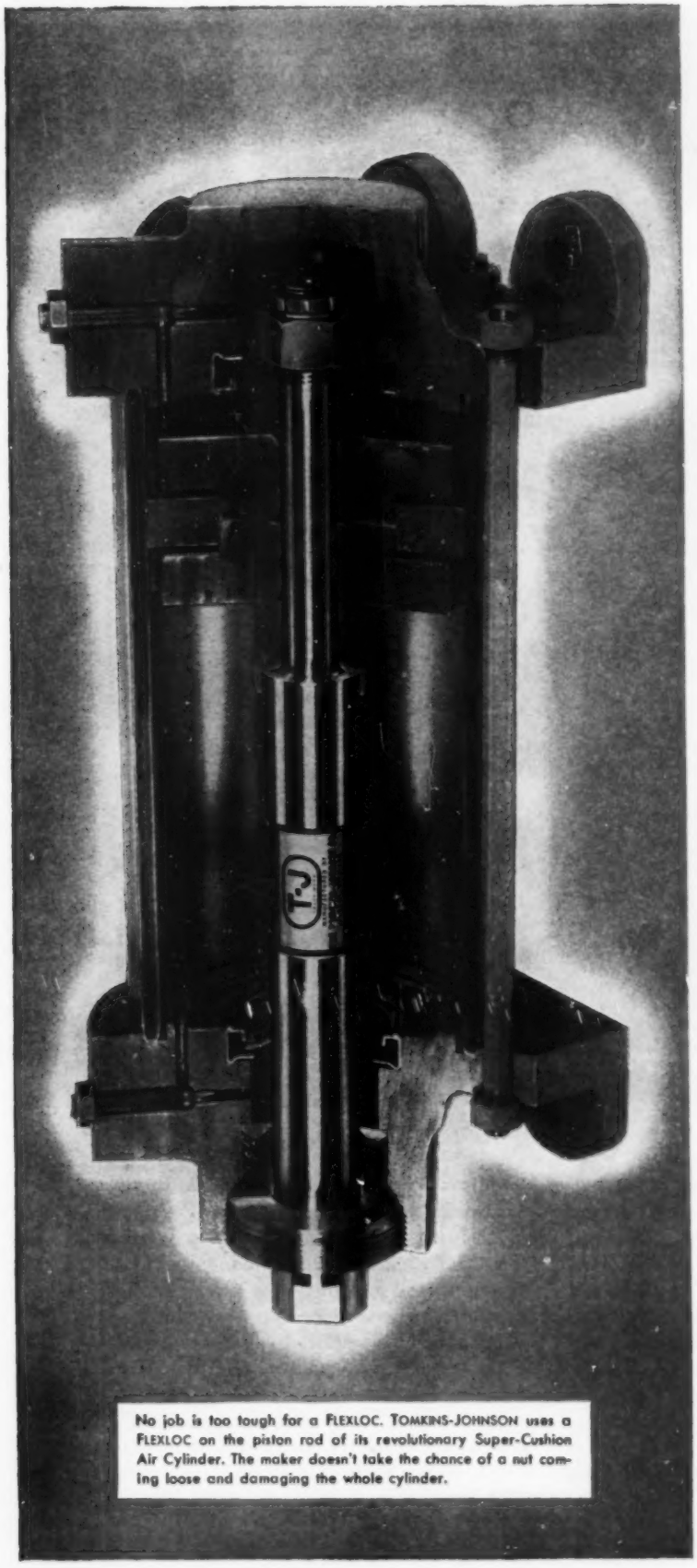
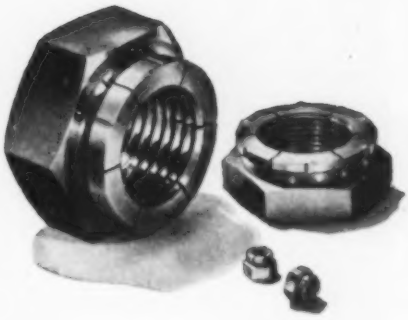


No job is too tough for a FLEXLOC. TOMKINS-JOHNSON uses a FLEXLOC on the piston rod of its revolutionary Super-Cushion Air Cylinder. The maker doesn't take the chance of a nut coming loose and damaging the whole cylinder.



What FLEXLOC locknuts do for you

FLEXLOCs eliminate complicated, time-consuming methods of locking threaded fasteners. They offer simpler, faster application and safer, more dependable locking than plain nuts and lockwashers, castellated nuts and cotter pins, or nuts and jam nuts. And they won't work loose.

The reasons for all this are plain. FLEXLOCs are one piece—nothing to assemble, come apart, lose or forget. FLEXLOCs are all metal—have higher tensile than most other locknuts and are not affected by temperatures to 550°F. FLEXLOCs are both stop and locknuts—don't have to seat to lock, and stay put anywhere on a threaded member as soon as their locking threads are fully engaged.

SPS can deliver any quantity of FLEXLOCs in a wide range of sizes. Stocks are carried by industrial distributors everywhere. Write for literature. SPS, Jenkintown 28, Pa.

FLEXLOC®

LOCKNUT DIVISION

SPS

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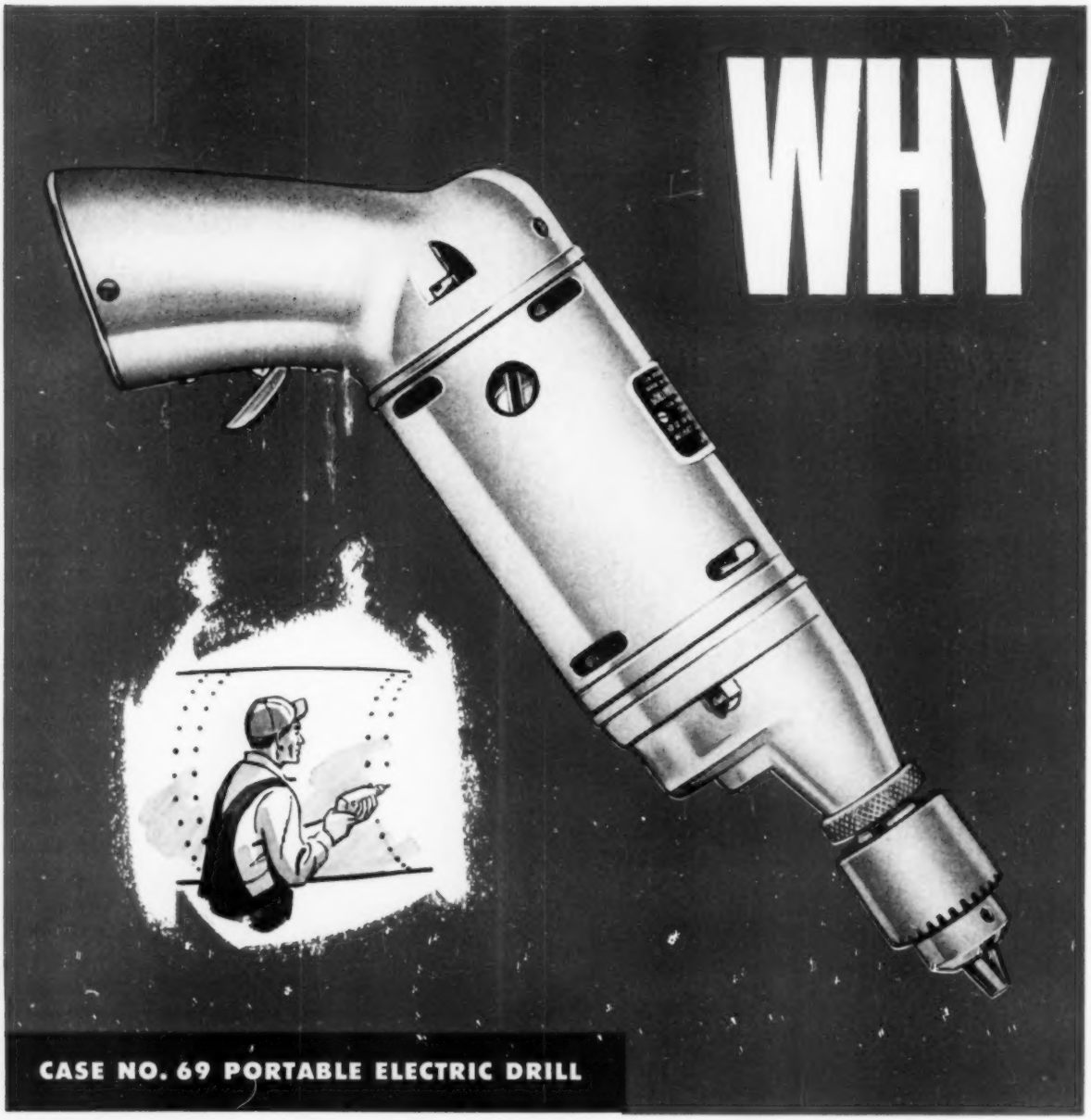
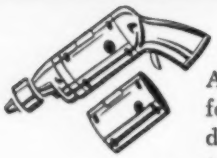
Our Fiftieth Year : A START FOR THE FUTURE





A switch to aluminum tubing for the housing of this electric drill permitted the manufacturer to capitalize on two important features of aluminum . . . its light weight and its naturally attractive finish.

The savings in weight is a direct selling point since lightness is of utmost importance in a hand tool of this kind. Furthermore, the manufacturer effected important savings in shipping costs.

Production and assembly costs were also cut since aluminum is easily fabricated and requires only simple buffing for finishing.

The manufacturer, Portable Electric Tools, Inc., of Chicago, Illinois, discovered also that aluminum is permanently non-rusting, will neither rust nor corrode should it become nicked or worn.

Perhaps this application of aluminum may suggest to you a similar conversion from other materials. Dollar savings in manufacturing and shipping costs, high corrosion resistance, naturally attractive finish plus added sales appeal are yours with aluminum.

LET ALUMINUM SERVE YOU, TOO

ALUMINUM?

...because it has an ideal combination of advantages found in no other metal!

More aluminum is being specified in designs today because aluminum improves products and increases sales. Let Reynolds Aluminum Specialists help your designers and engineers get maximum benefits from this modern metal. Remember, only aluminum gives you . . .

- ★ **Lightweight with great strength**
- ★ **Consistently low cost**
  no more now than before World War II
- ★ **Natural resistance to rust and corrosion**
- ★ **Attractive appearance**
- ★ **Ease of fabrication by modern methods**

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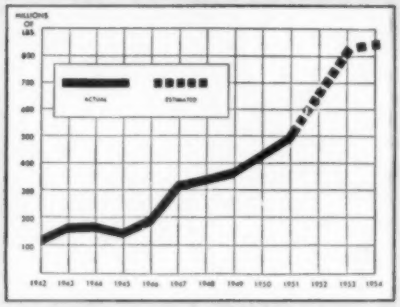

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To the man in charge of production

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Why Stemm Brothers' designers use Morse Roller Chains on their Hi-Tender

The Hi-Tender, manufactured by Stemm Brothers, Inc., is a simple, reliable, highly flexible machine that helps workmen do hours of overhead work in minutes.

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The Morse Roller Chains and Sprockets are used to transmit power smoothly and control it—with no slippage. They're used because of the long, trouble-free service life they give. They're tough, precision-built; can take hard use day after day and come back for more. They reduce machine down-time to a minimum, require little maintenance.

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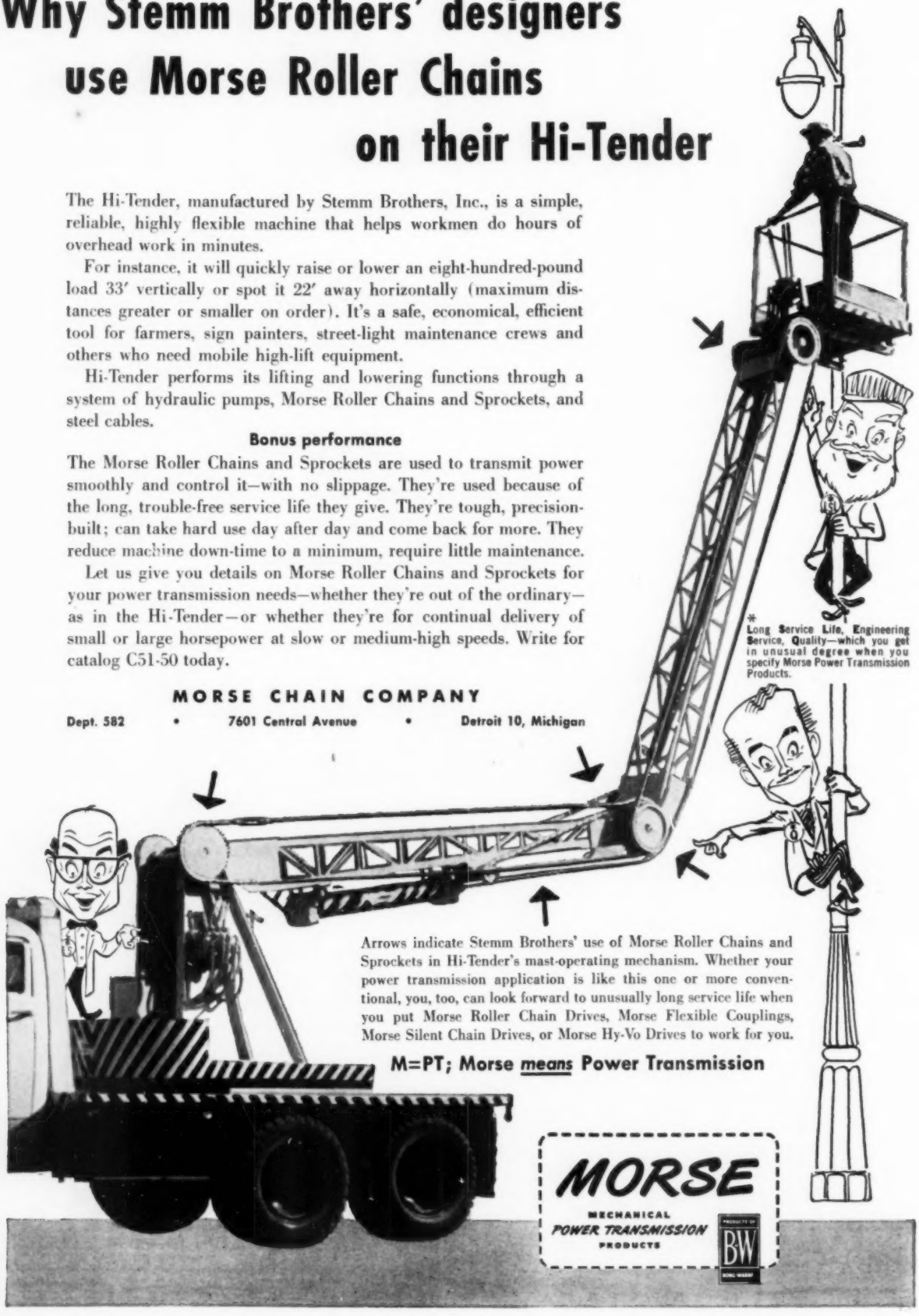

* Long Service Life, Engineering Service, Quality—which you get in unusual degree when you specify Morse Power Transmission Products.

Arrows indicate Stemm Brothers' use of Morse Roller Chains and Sprockets in Hi-Tender's mast-operating mechanism. Whether your power transmission application is like this one or more conventional, you, too, can look forward to unusually long service life when you put Morse Roller Chain Drives, Morse Flexible Couplings, Morse Silent Chain Drives, or Morse Hy-Vo Drives to work for you.

M=PT; Morse *means* Power Transmission

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PRODUCTS

NOW YOU CAN

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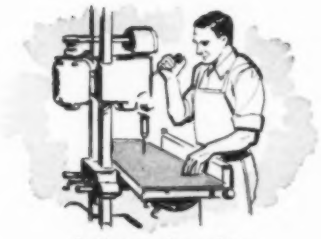
DU PONT VITREOUS ENAMEL FOR ALUMINUM

PERMITS ELIMINATION OF COSTLY PREFABRICATION

REMARKABLE NEW FINISH WITHSTANDS:



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Welding on reverse side

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Aluminum sheet, finished with Du Pont vitreous enamel, can be cut to size on the job—without damaging the coating! Costly prefabrication is eliminated. Rigidity is increased as much as 60% by a single standard coating of vitreous enamel . . . permitting the use of lighter gauge metal in many more applications.

Du Pont vitreous enamel is available in a virtually unlimited range of colors and degrees of surface gloss . . . can be readily applied with ordinary enameling and firing procedures—even over welded surfaces. Durable and lightfast, this rugged finish resists corrosion, abrasion, thermal shock, impact and flexing . . . has a high dielectric strength. Small imperfections in the enamel coating can be easily repaired by patching and refiring.

Investigate Du Pont vitreous enamel for aluminum. It's a practical way to make your product look better, wear longer and sell faster. Send the coupon below for details. We'll be glad to supply you with technical literature and give you specific recommendations on how the enameling process can best be adapted to your individual needs. And, at your request, we can also put you in touch with enamelers who are completely familiar with the vitreous enamel process.

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COPPER ALLOY BULLETIN

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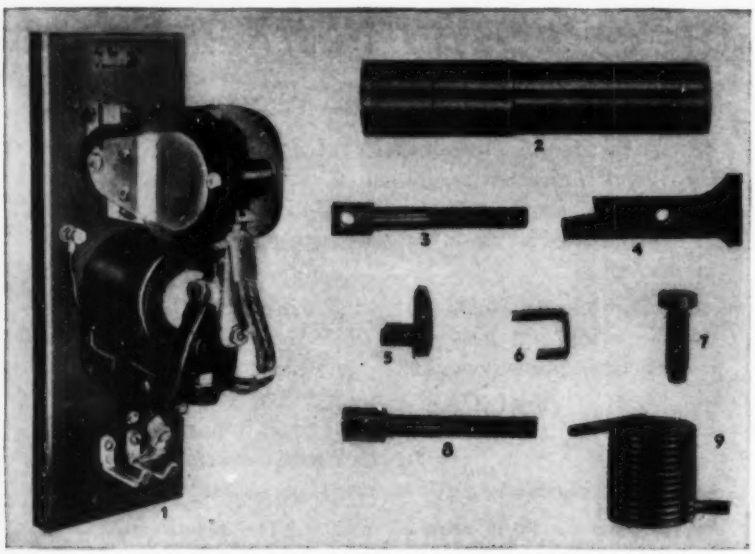


Vari-Time Magnetic Contactor and copper-base alloy parts, courtesy The Clark Controller Co., Cleveland, Ohio.

Copper and its Alloys Ideal for Heavy Duty Contactors

D.C. Magnetic Contactors are used as motor starters, crane controls, press controls, furnace controls, etc. They must be capable of handling anywhere from 25 to 900 amperes, open and close rapidly with a minimum of arcing and burning, and withstand corrosion even when exposed to the elements. In order to meet these requirements, high conductivity copper and alloys such as free cutting brass and Phosphor Bronze are used to manufacture those parts which form the electrical circuit. Some parts such as the studs, contact tips and arc horns, which require machining, are less costly to produce because of less tool wear and spoilage when using copper or brass.

Vari-Time Contactor

Illustrated is a Clark Controller Vari-Time Magnetic Contactor (1) which contains a special core providing an adjustable time delay before closing after the coil has been energized. The timer (2) consists of a core tube machined from free-cutting brass bar stock. The I.D. of the tube is reamed smooth and has a tolerance of ± .0005". Other copper-base alloy parts are the core cap and valve seat, both machined from free-cutting brass and a washer made from commercial bronze. The assembled core is filled with a special oil of controlled viscosity, and then the core tube is sealed with the core cap which is soldered in place. The timing is adjusted by an adjustable stop stud on the front of the contactor which varies the gap between the armature and the front of the core. The entire VT Core is so designed and constructed as to give exceptionally long life. At various times, after years of hard service, Vari-Time cores have been taken apart and rigidly inspected with no appreciable wear or deterioration.

Other copper alloy parts used on the contactor are as follows:

Blowout Stud (3) — This stud is machined from high conductivity hard copper square bar stock and then silver coated. It holds the blowout coil to the slate and also provides a terminal for power connection.

Rear Contact Stud (4) — This extruded part is made from free cutting brass rod which is silver coated after being drilled and tapped. To this stud are connected the other end of the blowout coil, the stationary contact tip and the rear arc horn.

Contact Tips (5) — A heated billet of high conductivity copper is forced through a die producing an oversized cross-section of the tip. This extrusion is then cold drawn through a sizing die which also imparts the correct hardness to the copper. Two contact tips are used on each contactor.

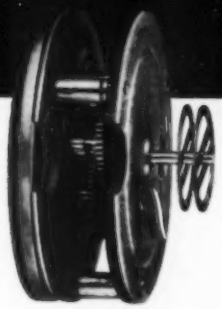
Front Arc Horn (6) — The front arc horn is formed from a Phosphor Bronze Grade A (95% copper, 5% tin, 0.15% phosphorus) strip while the rear arc horn, not illustrated, is formed from a high conductivity copper strip. Both arc horns are silver coated. The horns extinguish the arc by lengthening it until it is broken.

Stop Stud (7) — Machined from Phosphor Bronze Grade B-1 alloy, this stud acts as a stop for the contact arm.

Connector Stud (8) — This part is machined from high conductivity hexagon-shaped copper rod. It connects one end of the connector assembly to the slate, and also serves as a power terminal connection.

Before you decide what copper alloy to use for a particular application, many factors must be taken into consideration. Bridgeport Brass produces many alloys, each one with its own distinctive properties. Contact the nearest Bridgeport branch office for assistance with any of your metal problems. (9247)

ROTOR SO LIGHT
...it floats on water!



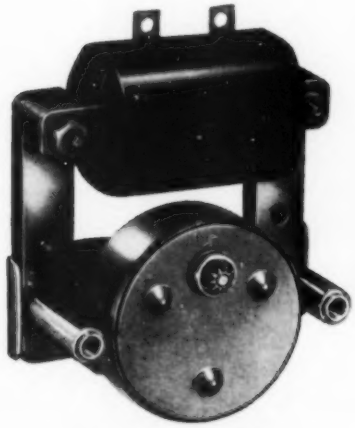
Rotor unit of H-3 motor
with cover removed

Telechron Synchronous Timing Motors

Hard, special-formula steel. Yet the rotor floats. It's so light, mere surface tension holds it up. Imagine what an advantage like this can mean to you when you specify Telechron Synchronous Timing Motors for your equipment.

There's little inertia to overcome. So Telechron motors start almost instantly—reach full speed in less than 3 cycles (1/20th sec.). Low-weight rotor virtually floats in the magnetic field. Rotor shaft rides on a film of oil—no metal-to-metal contact—giving longer life, and assuring true synchronous operation.

These advantages are yours in all models of Telechron Synchronous Timing Motors—no matter what the application. Let us help you select the model that will best give you the performance you are looking for. Write for complete catalog and information on our Application Engineering Service. Telechron Department, General Electric Company, 14 Homer Ave., Ashland, Mass.



Model H-3—for radio timers,
process timers, and time switches

Telechron®
MARK OF TIMING LEADERSHIP

GET OUR *Free* 6-PAGE FOLDER

See where and how we mass-manufacture Small Gearing to uniformly fine tolerances. This attractively printed 8½ x 11" 6-page folder is punched for ring-binder use. You'll want to keep it handy for frequent reference. It contains 23 pictures of Small Gears, plant views, as well as Diametral and Circular Pitch Tables. Ask for your copy on company stationery, please!

IT DOESN'T PAY TO *monkey with* ORDINARY SMALL GEARS

When Fractional Horsepower Gearing is involved, *only the finest is good enough.* Moreover, that top quality must be *perfectly uniform,* always. The inescapable penalties of "monkeying with" *ordinary* Small Gears are rejects, downtime, delays, and profit-destroying performance. ★ Transmitting power successfully in production runs of small, high-speed mechanisms is a job for *experts.* Here at G.S. we've specialized in doing this ONE job exceptionally well, for more than 35 years! Special skills and facilities have been perfected to mass-manufacture Small Gearing with almost uncanny accuracy. That's why the growing list of our customers looks like a blue book of industry. Sheer merit, alone, has made us the "World's Largest Exclusive Manufacturers of Fractional Horsepower Gearing"! Tell us about *your* needs. We'll be quick to help you, effectively.

FRACTIONAL HORSEPOWER GEARING

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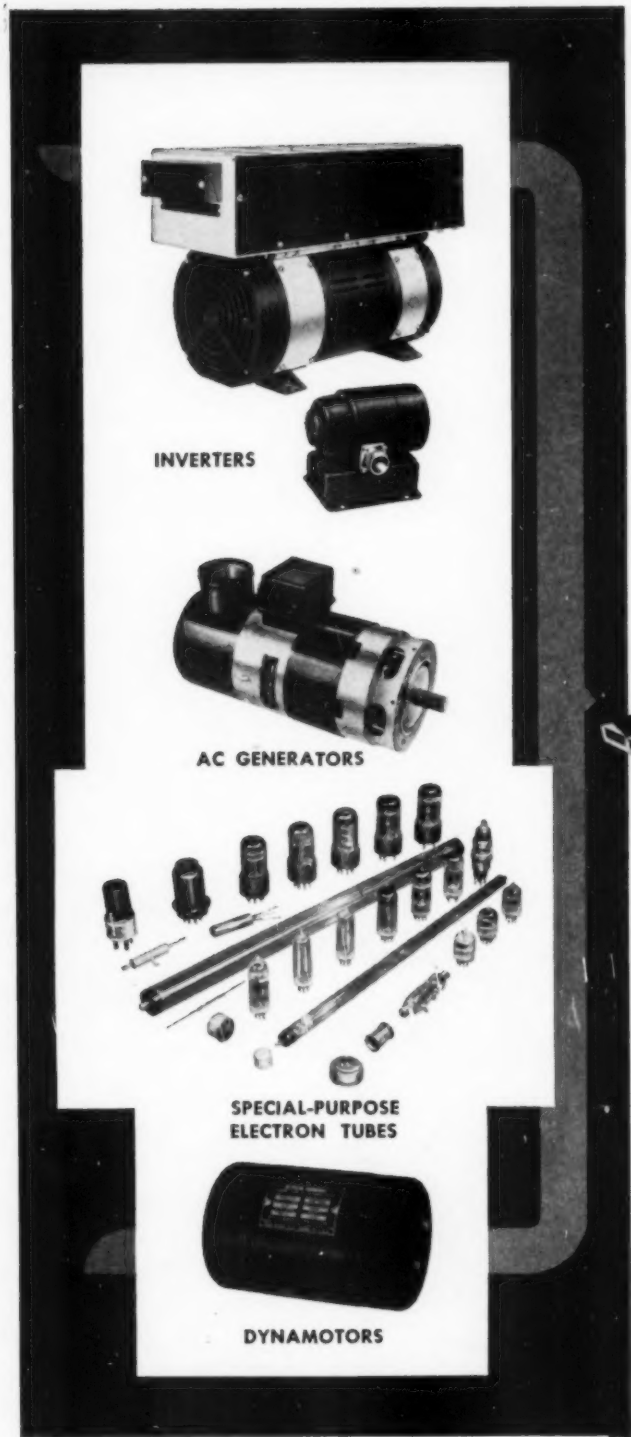
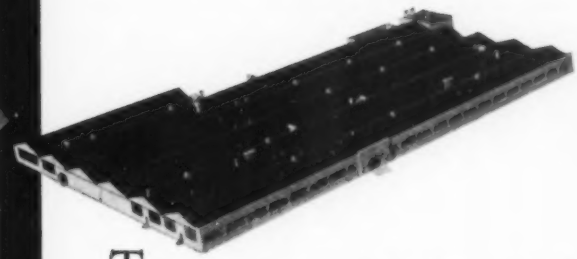
WORLD'S LARGEST EXCLUSIVE MANUFACTURERS
OF FRACTIONAL HORSEPOWER GEARING



Bendix Aviation Corporation

concentrates development, sales and production of special-purpose electron tubes, inverters and AC generators with its dynamotors and small motors at its

Red Bank Division



To provide its customers with an unequalled source for special-purpose electron tubes, inverters and AC generators, Bendix Aviation Corporation has placed its entire development, sales and manufacture of these products with its Red Bank Division at Eatontown, N. J. Here in a modern new plant of over 118,000 square feet have been concentrated the most highly skilled personnel and the latest available machinery to produce the highest quality electron tubes, inverters and AC generators possible. At the same time, a full-scale program is being carried on continuously at Red Bank to develop these products for even greater efficiency and versatility. In addition to its new products . . . taken over from the Eclipse-Pioneer Division, Teterboro, N. J. . . . the Bendix Red Bank Division will continue producing its established line of dynamotors and small DC motors. If you require precision items of these types, it will pay you to take advantage of the unique experience and facilities offered to you by Bendix Red Bank.

Division of Bendix Aviation Corporation — THE NAME Bendix MILLIONS TRUST

Bendix Red Bank

EATONTOWN, NEW JERSEY

Export Sales: Bendix International Division, 72 Fifth Avenue, New York 11, N. Y.

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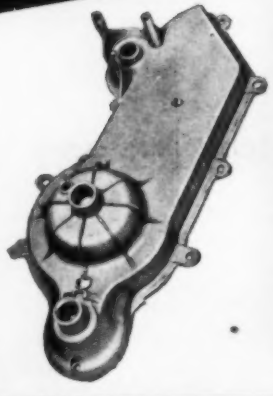

...for maximum strength, greater wear resistance, and ease of machining.

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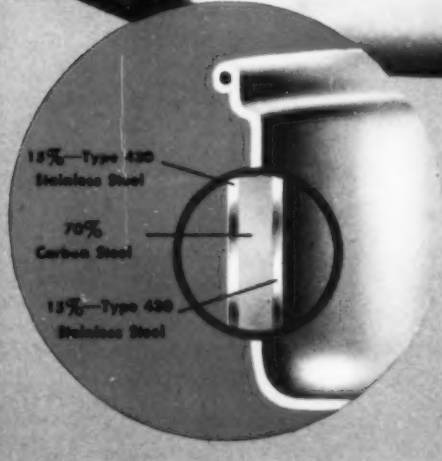


Fast, Even Heat Diffusion . . . No Hot Spots!

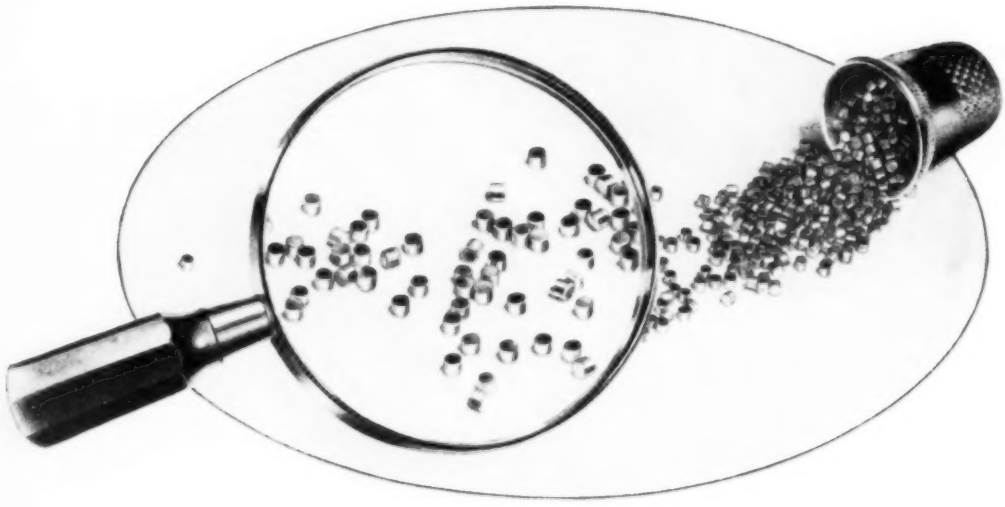
The word travels fast among consumers: get *stainless-clad* utensils now for better cooking . . . easy cleaning . . . stay-bright beauty! And the utensil maker says SuVENEER Stainless Clad Metal . . . for fabricating ease . . . for sales! Stainless both sides, mild steel in the center, furnished in coiled strip. Size, temper, finish to your specification. *Write.*

Superior Steel

CORPORATION

CARNEGIE, PENNSYLVANIA

Millions of Cycles of Contact Life . . .



At One-Third the Cost

Nearly a thousand of these contacts will fit in a thimble, yet the accuracy of a gasoline gauge depends on their uniform performance over a life measured in millions of cycles.

The instrument is designed so that the varying width of the contact gap controls the gauge. As a result, the contact gap is extremely critical. Once the gauge is calibrated, the contacts must retain their shape precisely. They have to resist the peening effect of high frequency operation. They must withstand the pitting and erosion of almost continuous arcing and still maintain low contact resistance with light pressure.

For this kind of an application, platinum and platinum alloys would seem to be the logical choice. There is just one drawback . . . the cost. This is where Mallory's experience in contact engineering was able to save the manufacturer two-thirds of his previous cost.

Through metallurgical techniques, Mallory creates new materials by combining the desirable characteristics of several metals. One of these materials is Elkonium 17, a silver-nickel-cadmium alloy which had the required characteristics . . . at a fraction of the cost.

Other Mallory contact materials will meet the requirements of virtually any electrical contact application. Whether your problem involves simple button or rivet contacts—or a complex assembly—take advantage of the experience our engineers have accumulated in the development of over 5000 different types of contacts and contact assemblies. Call us today . . . lower your production costs tomorrow.

Expect more . . .
Get more from **MALLORY**

In Canada, made and sold by Johnson, Matthey and Mallory, Ltd., 110 Industry Street, Toronto 15, Ontario

Electrical Contacts and Contact Assemblies

P.R. MALLORY & CO. Inc.
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SERVING INDUSTRY WITH THESE PRODUCTS:
Electromechanical—Resistors • Switches • Television Tuners • Vibrators
Electrochemical—Capacitors • Rectifiers • Mercury Dry Batteries
Metallurgical—Contacts • Special Metals and Ceramics • Welding Materials

P. R. MALLORY & CO., INC., INDIANAPOLIS 6, INDIANA

AB Breakers pioneer greater capacity— smaller size

Always the leader in better-engineered circuit protective devices, Westinghouse sets a new pace with four compactly designed products that spell more capacity in less space than ever before possible.

The new J Breaker is only 10⅛″ high compared with 15½″ for conventional 225-amp breakers. Saves at least 34% mounting space in panels, switchboards, control cabinets and other enclosures.

The new E Breaker, formerly rated 50 amps, has been redesigned for 100 amps with no increase in size. A panel of 100-amp E's gives the same capacity but saves the price of heavy duty panelboards.

The new Quicklag Plug-in Thermal-magnetic De-ion® Breaker saves 25% mounting space. Plug-in contacts speed assembly. New type terminals end looping of wires.

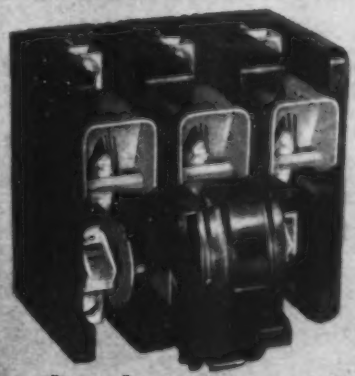
The new 60-amp Visible Blade De-ion Switch is a fusible or non-fusible disconnect for all types of control panels up to 50 hp, 600 volts a-c. It's smaller, has higher interrupting capacity than any device of comparable rating.

These new products are available now, fully listed by Underwriters' Laboratories, Inc. For complete details call your Westinghouse Representative or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa. J-30144

225 amp J Breaker — saves 34% space

100 amp E Breaker — doubles former capacity

Quicklag Breaker — 25% smaller



60 amp "De-ion" Switch — measures 4" x 4"

YOU CAN BE SURE...IF IT'S Westinghouse

Announcing

General Plate
CONFLEX
Copper-Clad
HARDENABLE
Steel

For High Conductive Electrical Spring Parts at Low Cost

Here's a new General Plate Composite Metal — *CONFLEX copper clad on hardenable medium carbon steel* — that can solve many of your electrical spring problems.

Comparable to beryllium copper in many respects, its primary advantage is *lower cost.* In addition, *CONFLEX copper-clad hardenable steel* has greater stiffness than hardenable copper alloys.

General Plate single or double copper-clad hardenable steel offers high electrical and thermal conductivity. Thickness ratios can be produced to give higher electrical conductivity than hardenable copper alloys when the same overall thickness of materials are compared.

CONFLEX copper-clad hardenable steel can be used advantageously for such applications as fuse clips, flat springs and electrical connectors. In other applications, such as pen and pencil clips, the layer of copper provides an excellent surface for an electro-plated finish.

General Plate products include . . . precious metals clad to base metals, base metals clad to base metals, silver solders, composite contacts, buttons and rivets, Truflex® thermostat metals, Alcuplate®, platinum fabrication and refining, #720 manganese age-hardenable alloy. Write for complete information and Catalog PR700 today.

You can profit by using General Plate Composite Metals!

METALS & CONTROLS CORPORATION
GENERAL PLATE DIVISION
14 FOREST STREET, ATTLEBORO, MASSACHUSETTS

open door to better service — with C-11 plastics

The door of every new Servel "Automatic Ice-Maker" refrigerator carries three shelves on its inner side. Shining and clean-lined, they accent the interior's up-to-the-minute styling. Molded from BAKELITE C-11 Plastics for toughness, they'll hold bottles, cans and jars of foods used most.

The shelves are molded to sharp detail in one minute between 580 and 660 deg. F. Each weighs only eight ounces. Spraying the under side with gold paint gives them their rich metallic luster. For attachment to the door, they have studs molded with holes that become self-threading when screws are inserted.

BAKELITE C-11 Plastics are acrylonitrile-styrene copolymers that have several features distinct from both acrylic and styrene plastics. One such feature is strength—their tensile and flexural strengths are 45% higher than those of standard polystyrenes. Another is durability—they withstand contact with tea, coffee, citrus peels, soaps, detergents, oils, cosmetics. Their dimensional stability is excellent.

With this combination of properties, BAKELITE C-11 Plastics are extending the usefulness of plastics in such fields as housewares, packaging, product design. For information, write Dpt. PX-10.

Door shelves for the Servel "Automatic Ice-Maker" Refrigerator molded by Kusan, Inc., Nashville, Tenn.

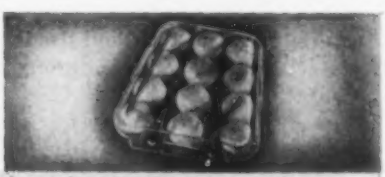
BAKELITE
TRADE-MARK
C-11 PLASTICS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
UCC
30 East 42nd Street, New York 17, N. Y.
In Canada:
Bakelite Company (Canada) Ltd., Belleville, Ont.

LASTING COLOR for slide fasteners is achieved with coatings based on VINYLITE Dispersion Resins. They withstand usage, cleaning solutions and boiling soapy water. By Stoner-Mudge, Inc., Pittsburgh 33, Pa. for Crown Fastener Corp.

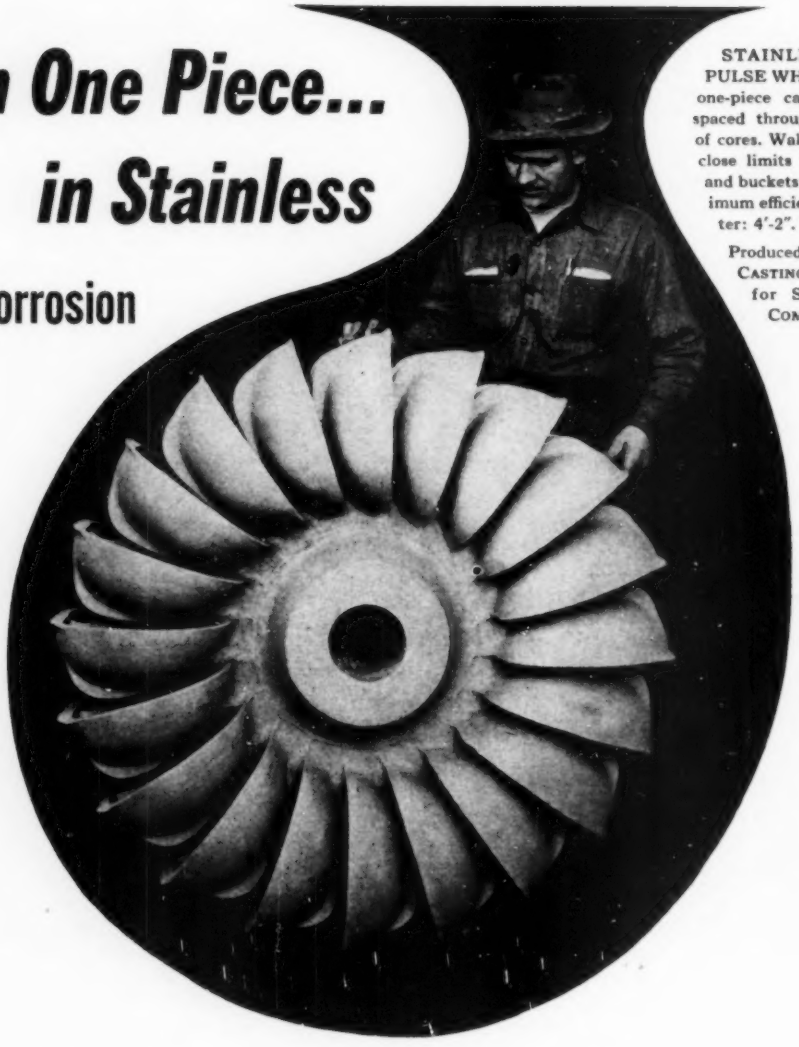
EYE-CATCHING PACKAGE for men's toiletries is made of transparent VINYLITE Plastic Rigid Sheets, printed and formed into this globe. It's light in weight, strong, and flexible. Made for Charbert, Inc., by Mechtronics, Inc., Mamaroneck, N. Y.



GOLF BALL CONTAINER of BAKELITE Styrene Plastic is combination display package with bottom half usable as practice putting hole, and cover that becomes utility shelf when attached to locker. Molded by Cowan-Boyden Corp., Providence, R. I.

Cast in One Piece... in Stainless

to resist corrosion



STAINLESS STEEL IMPULSE WHEEL. Buckets in this one-piece casting are accurately spaced through proper alignment of cores. Wall sections are held to close limits to maintain balance, and buckets are polished for maximum efficiency of wheel. Diameter: 4'-2". Weight: 2200#.

Produced by EMPIRE STEEL CASTINGS, INC., Reading, Pa., for S. MORGAN SMITH COMPANY, York, Pa.

Corrosion meets its master in this impulse wheel of cast austenitic stainless steel containing 19 percent chromium and 9 percent nickel...

Furthermore... in hydroelectric power generation, under the terrific impact of a "high head" of falling water... this *stainless* casting tends to work harden while putting water to work, thereby improving its resistance to erosion and abrasion.

Impulse wheels are only one of countless applications in which advantage may be taken of the various useful properties of chromium-nickel stainless steels.

You can trim bulk and deadweight by specifying correct types of stainless. Strong and tough, stainless steels resist wear and attack by nearly all oxidizing acid conditions. Moreover, complexity of design is not a limiting factor in casting chromium-nickel stainless.

Austenitic stainless steels resist creep, scaling and oxidation at elevated temperatures. And at sub-zero temperatures, they offer exceptional resistance to impact.

Investigate all the economies you may obtain by using stainless steel equipment. Send us your inquiries on the use of cast or wrought stainless alloy steels. Write us details of your problems for our suggestions.

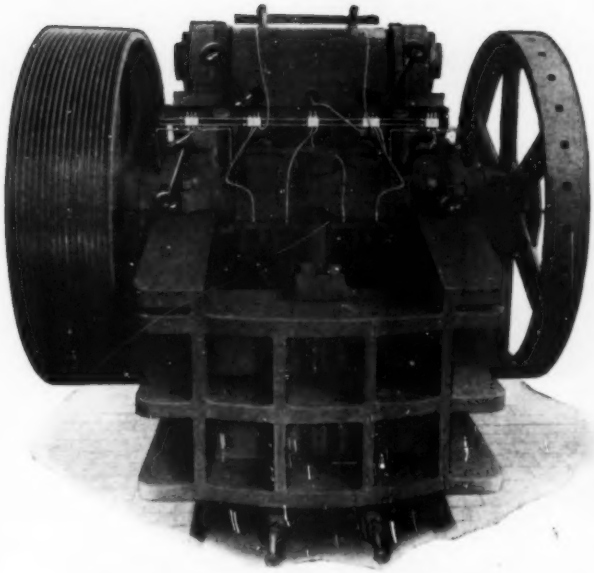
At the present time, nickel is available for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET NEW YORK 5, N. Y.

FARVAL—*Studies in Centralized Lubrication* No. 141

Dust-proof lubrication of Traylor jaw crusher insured by Farval



KEYS TO ADEQUATE LUBRICATION—Wherever you see the sign of Farval—the familiar valve manifolds, dual lubricant lines and central pumping station—you know a machine will be properly lubricated. Farval manually operated and automatic systems protect millions of industrial bearings.

Photo of Farvalized jaw crusher by courtesy of Traylor Engineering Company.

YOU can't fool a rock crusher with grease cups and wick feeds. Sooner or later, dirt clogs these devices and gets into the bearings. Abrasive dust cuts. Shutdowns occur. Production stops.

The builder of this 48″x 60″ jaw crusher didn't take chances with bearing troubles. He chose a foolproof Farval system. Centralized lubrication keeps bearings at top operating efficiency and sealed to repel invasion of dirt and dust.

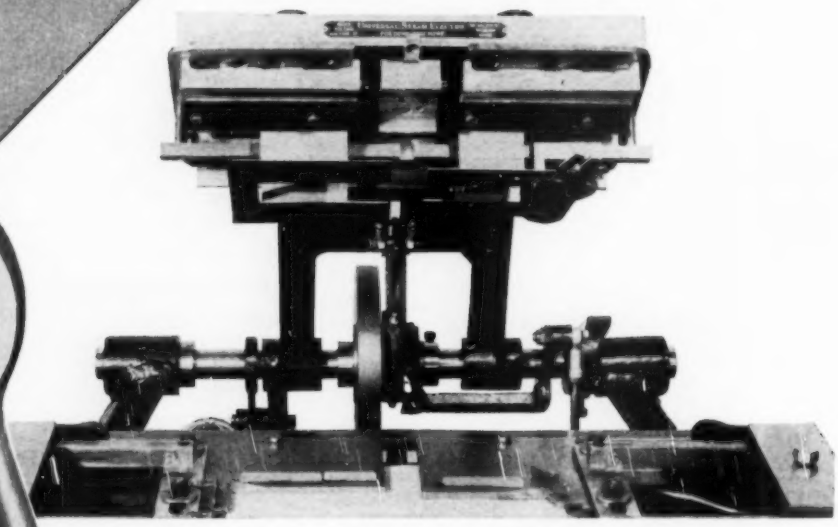
Farval delivers oil or grease under pressure to a group of bearings from one central station, in exact quantities, as often as desired. The Farval valve has only two moving parts—is simple and sure. No springs, ball checks or pin-hole ports to cause trouble. Farval lubricates while the equipment is working—keeps bearings cool regardless of the kind and quantity of material being crushed. And Farval completely eliminates the need for a hand oiler to clamber over slippery surfaces. Lubrication is safe, sure, cheap—saves labor, production time, bearing expense and lubricants.

With industry moving at high speed, more and more builders and users of machinery and industrial equipment of all kinds look to Farval for continuous bearing protection—low-cost positive protection that has been a Farval trade-mark for over 26 years.

There's a specific Farval system suitable for almost any type and size machine. For information and help, consult the Farval engineer who's near you to serve you. Or write for Bulletin 26. You'll be amazed at the savings in labor, lubricant, and increased bearing life Farval can bring. The Farval Corporation, 3279 E. 80th St., Cleveland 4, Ohio.

Affiliate of The Cleveland Worm & Gear Company, Industrial Worm Gearing. In Canada: Peacock Brothers Limited.

Heim spherical bearing rod ends as used on ... the Reece Folding Machine



The Reece Folding Machine, made at Woburn, Mass., is widely used in the clothing industry to fold in and press flat parts of garments which are subsequently sewn to the main body of the garment, for instance, shirt pockets. The final motions of the machine are derived from cams and transmitted by levers and rods to the working area.

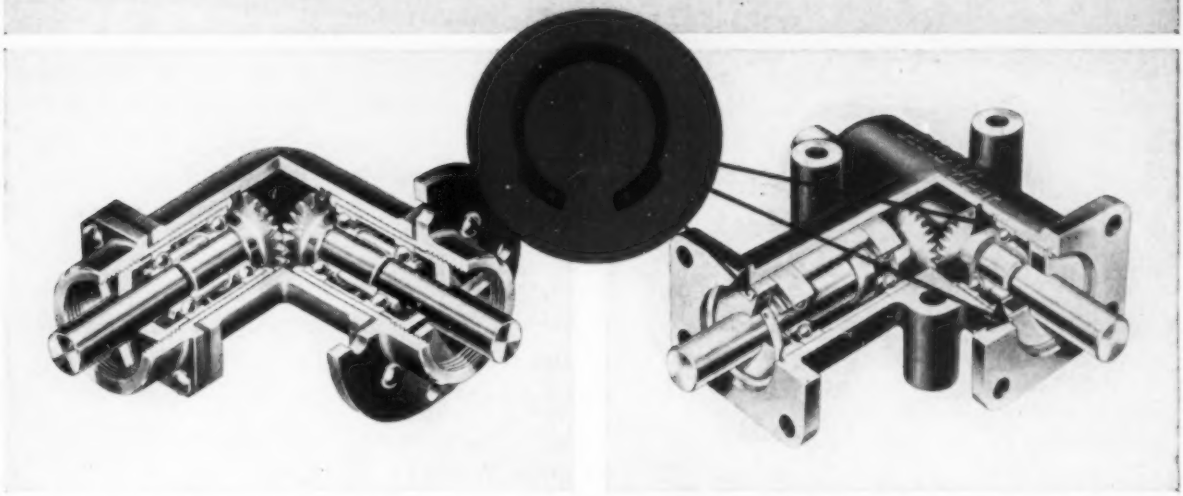
Twelve Heim Unibals are used in the standard model and more in special adaptations. They are used to connect oscillating levers moving in different planes and to avoid the necessity of carefully lining up connected parts. Reece feels that the quality of Heim Unibal construction adds to the life of all joints where used.

For changing lateral motion or power to vertical or transverse motion, you too can obtain better results with Heim Unibal Spherical Bearing Rod Ends.

The Heim Company, Fairfield, Connecticut

Write now for complete catalog of Heim Bearings.

3 Waldes Truarc Rings Replace 19 Parts ...Save $6.75 Per Unit...Cut Weight by Nearly 16%



OLD WAY 2 Threaded nuts locked bearings in place. 8 screws and washers positioned bearing and shaft assemblies. This fastening method required expensive tapping and threading. Assembly was slow and costly.

TRUARC WAY Two Truarc inverted rings (Series 5008) provide uniform shoulder to lock bearings in place, position bearing and shaft assemblies. Additional Truarc Ring (Series 5100) locates ball bearing ...eliminates 1 sleeve type spacer.

Airborne Accessories Corporation, Hillside, New Jersey, uses Waldes Truarc Retaining Rings to take *all* thrust load from right angle bevel gears in their ANGLgear*. Truarc Rings make ANGLgear* more compact—save approximately ¼" at each end of housing. By providing a choice of 3 mounting possibilities — instead of 1 — Truarc Rings make ANGLgear* adaptable to many different assemblies. New design increases load capacity . . . eliminates machining of threads.

Redesign with Truarc Rings and you, too, will cut costs. Wherever you use machined shoulders, bolts, snap rings, cotter pins, there's a Waldes Truarc Retaining Ring designed to do a better job of holding parts together.

Waldes Truarc Rings are precision-engineered . . . quick and easy to assemble and disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your blueprints to Waldes Truarc engineers for individual attention, without obligation.

*Trade Mark of Airborne Accessories Corp.

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RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,410,052; 2,420,921; 2,420,341; 2,439,705; 2,441,846; 2,459,169; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,309; 2,509,081 AND OTHER PATENTS PENDING.

Waldes Kohinoor, Inc., 47-16 Austel Place, L. I. C. 1, N. Y.

Please send me the new Waldes Truarc Retaining Ring catalog.

(Please print)

Name_____

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Company_____

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PN-945

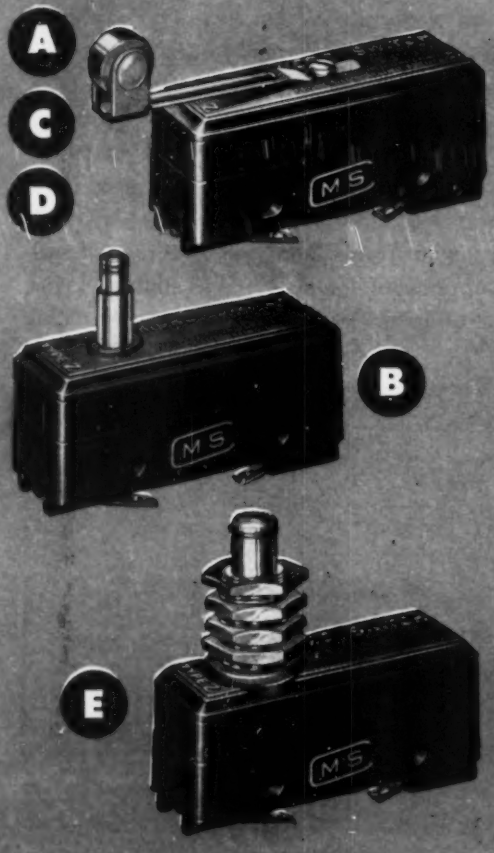
24 MICRO precision switches perform vital functions

These 3 MICRO switches of 8 different types function to make Robot the first fully automatic washer

● The three designs of MICRO switches shown include eight different types of operating characteristics and circuit arrangements required as controls for the Robot washer.

All have the MICRO characteristics of small size, light weight, accurate repeatability of operating point, high electrical rating and long-life dependability.

Letters indicate the location of these three MICRO switch designs in the open view of the Robot washer on the opposite page.



● This fully automatic commercial washer, which does the work of two or more manual washers, was developed by engineers of the Robot Laundry Machinery Sales, a division of the Wolf Company, Chambersburg, Pa.

Through the use of 24 MICRO precision switches, of eight different types, the designers were able to produce the first and only self-contained and completely automatic washer.

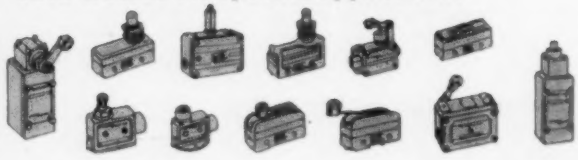
Under the automatic control of these MICRO switches, the Robot Washer—

1. Pre-mixes and releases supplies
2. Measures pre-determined gallonage of water
3. Controls water temperatures
4. Times each washing cycle
5. Injects steam at proper time
6. Dumps washer when cycle is completed

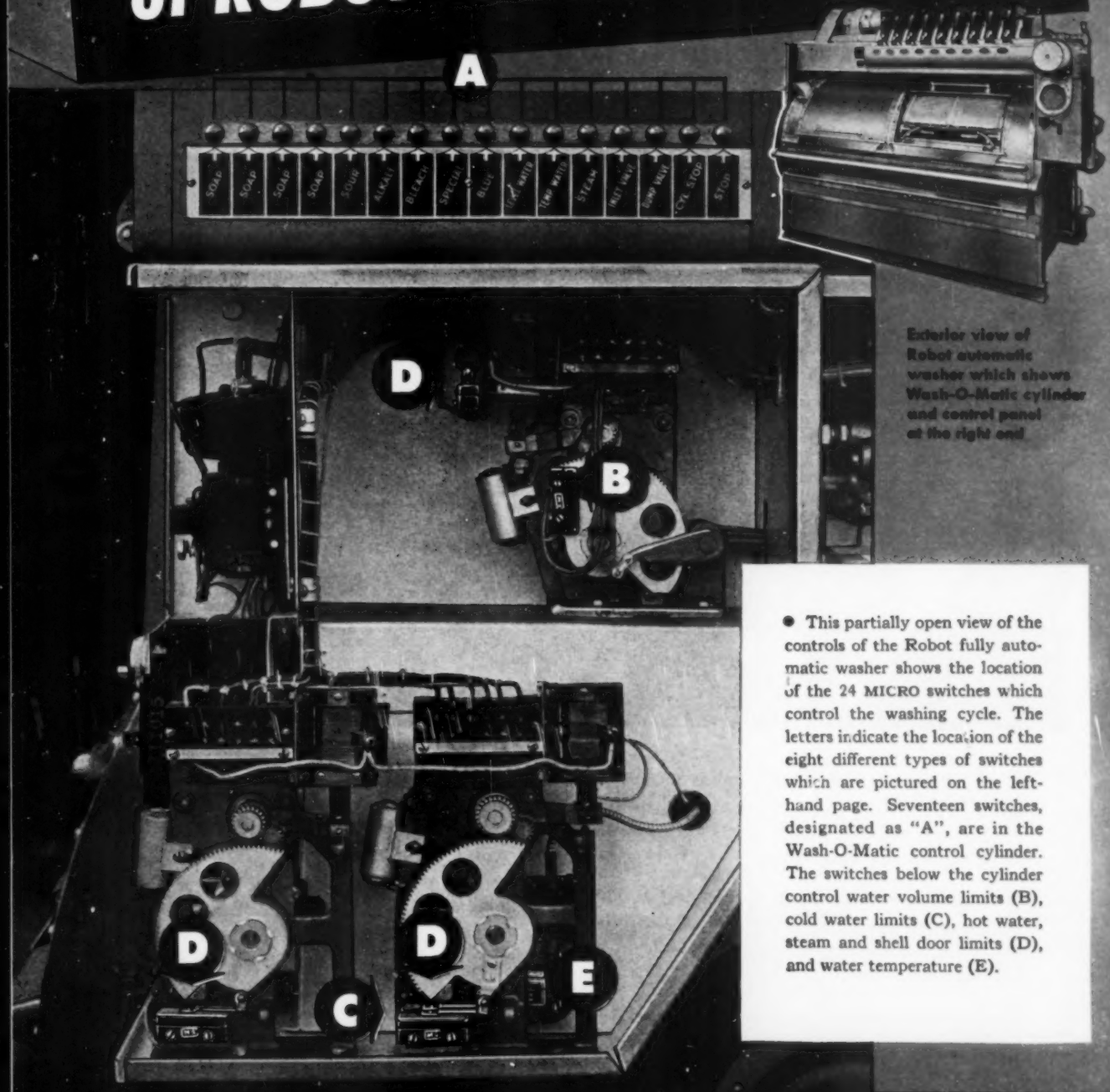
MICRO switches were chosen by Robot design engineers because of their long-life dependability and high electrical capacity . . . plus the ability of MICRO engineering to provide all the different types of switches which were required to control each operation most efficiently.

Whatever your design problem, you will find MICRO switches and MICRO field engineering counsel available to help you put not just *a* switch, but *the right switch in the right place*. These MICRO engineers, fully experienced in every type of switch application, have over 6000 variations of MICRO precision switches from which to help select the right switch for your design. We invite you to contact your nearest MICRO branch office.

OVER 6000 DIFFERENT SWITCHES . . .
Each created for specific applications



to provide automatic control of ROBOT commercial washer



Exterior view of Robot automatic washer which shows Wash-O-Matic cylinder and control panel at the right end

● This partially open view of the controls of the Robot fully automatic washer shows the location of the 24 MICRO switches which control the washing cycle. The letters indicate the location of the eight different types of switches which are pictured on the left-hand page. Seventeen switches, designated as "A", are in the Wash-O-Matic control cylinder. The switches below the cylinder control water volume limits (B), cold water limits (C), hot water, steam and shell door limits (D), and water temperature (E).

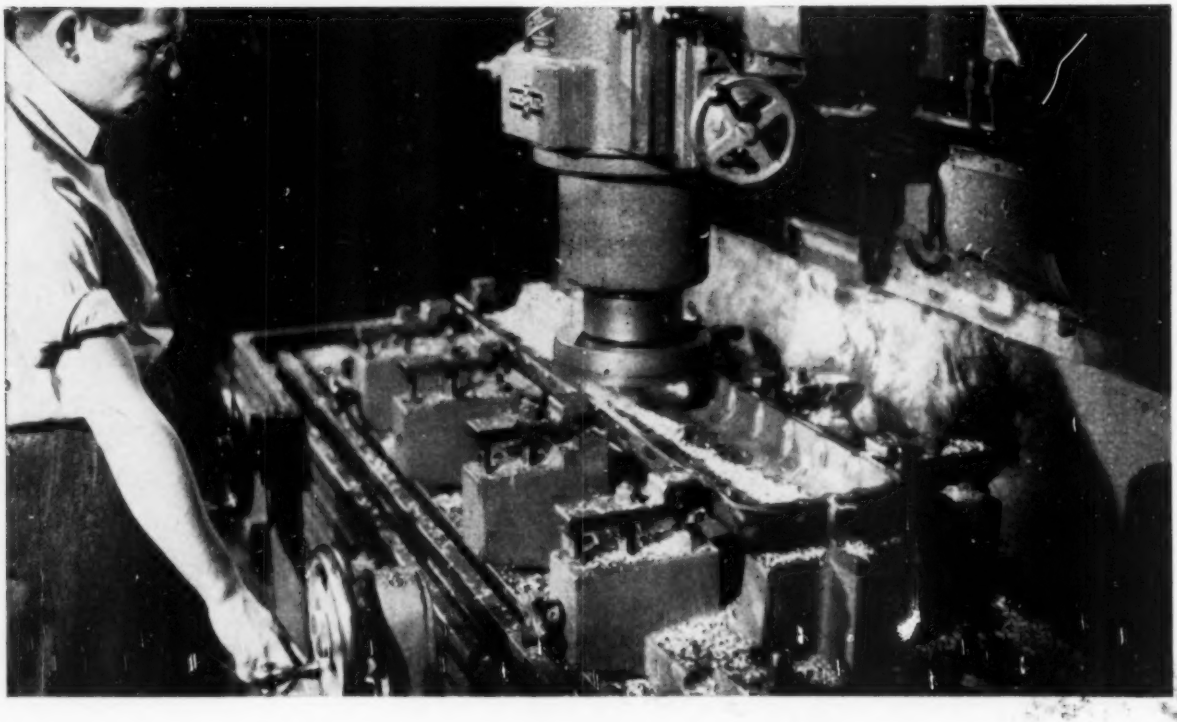
MICRO
MAKERS OF PRECISION SWITCHES
FREEPORT, ILLINOIS

A DIVISION OF
MINNEAPOLIS-HONEYWELL REGULATOR COMPANY

DOW

MAGNESIUM OFFERS YOU SUPERIOR MACHINABILITY

Increased tool life and lower machining costs are possible



Of all structural metals, magnesium is the easiest to machine. Heavier depths of cut and higher rates of feed than are used on other metals are possible when machining magnesium.

With increased machining speeds, magnesium helps you realize savings in production costs, particularly when extensive machining operations are required.

Magnesium cuts freely, too, assuring increased tool life. In fact, the life of high-speed steel cutting tools when machining wrought magnesium equals the life of carbide-tipped tools on other metals.

Excellent surface finish is obtainable when machining magnesium because there is no tendency for metal to tear or drag. Extremely accurate parts with dimensional tolerances of only a few ten thousandths of an inch can be made by standard machining operations.

Free Book: "MACHINING MAGNESIUM". This fact-filled book will give you complete data on all machining operations with magnesium. It also includes information on tool design, coolants and shop practice. For your copy, call your nearest Dow sales office or write THE DOW CHEMICAL COMPANY, *Magnesium Department*, Midland, Michigan.

you can depend on DOW MAGNESIUM

DOW

HYDRAULICS FOR MOBILE EQUIPMENT

VOL. 1

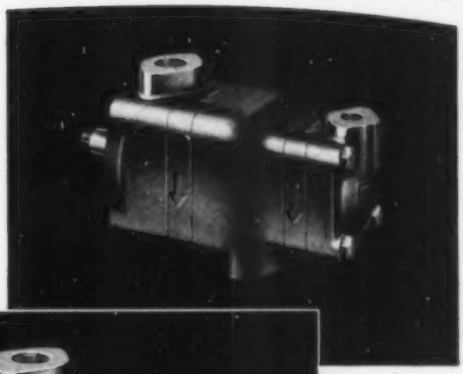
Mobile Equipment News

VICKERS INCORPORATED, DETROIT, MICHIGAN

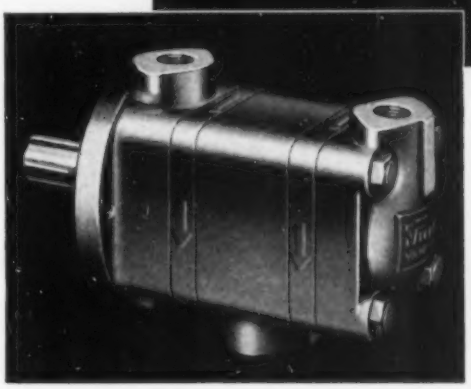
IMPROVES PERFORMANCE • CUTS COSTS

NO. 3

26 MORE VICKERS DOUBLE PUMPS NOW IN PRODUCTION



(Right) Series V-2200 Double Pump in 10 sizes from 3.2 to 32.6 gpm combined delivery.



(Left) Series V-3200 Double Pump in 16 sizes from 11.9 to 51.1 gpm combined delivery.

OFFER MANY REAL BENEFITS WHEN TWO HYDRAULIC CIRCUITS ARE USED ON MOBILE EQUIPMENT

These double pumps are becoming increasingly popular wherever two machine components must operate simultaneously at different speeds and/or operating pressures. They also prevent all possible chance of one operation interfering with another.

TWO PUMPS IN TANDEM

These are essentially two pumps in a single housing and driven by a common shaft. Independent pressure control must be provided as there is a separate pressure outlet for each pump.

LONGER PUMP LIFE RESULTS FROM HYDRAULIC BALANCE

Like Vickers Vane Type Single Pumps, these double pumps have the exclusive Vickers "Hydraulic Balance" that eliminates pressure-induced bearing loads and results in longer pump life.

NO-LOAD STARTING

At rest and normal starting speeds, the sliding vanes are retracted; only after engine fires do vanes extend and pumping begin.

COMPACT AND EASILY INSTALLED

Greater mounting adaptability because of minimum space requirement, 3 mounting styles, optional and independent piping connection positions, shaft drive in either direction.

ASK FOR NEW BULLETIN M-5101

TOP PERFORMANCE THROUGHOUT PUMP LIFE BECAUSE OF AUTOMATIC WEAR COMPENSATION

Radial compensation for normal wear and temperature differentials is provided by the movement of the vanes in the rotor slots. (Wear is minimized because all parts are lubricated by the oil under pressure.)

Axial compensation is by means of a pressure plate held to optimum running clearance by pressure from the system.

Automatic compensation eliminates need for "run in" . . . efficiency is maximum the first time the pump is started. It also assures maximum delivery over a very long life and with wide oil temperature change.

VICKERS Incorporated

DIVISION OF THE SPERRY CORPORATION

1454 OAKMAN BLVD. • DETROIT 32, MICH.

Application Engineering Offices: ATLANTA • CHICAGO (Metropolitan) CINCINNATI • CLEVELAND • DETROIT • HOUSTON • LOS ANGELES (Metropolitan) • NEW YORK (Metropolitan) • *PHILADELPHIA (Metropolitan) • PITTSBURGH • ROCHESTER • ROCKFORD • SEATTLE TULSA • WASHINGTON • WORCESTER

4230

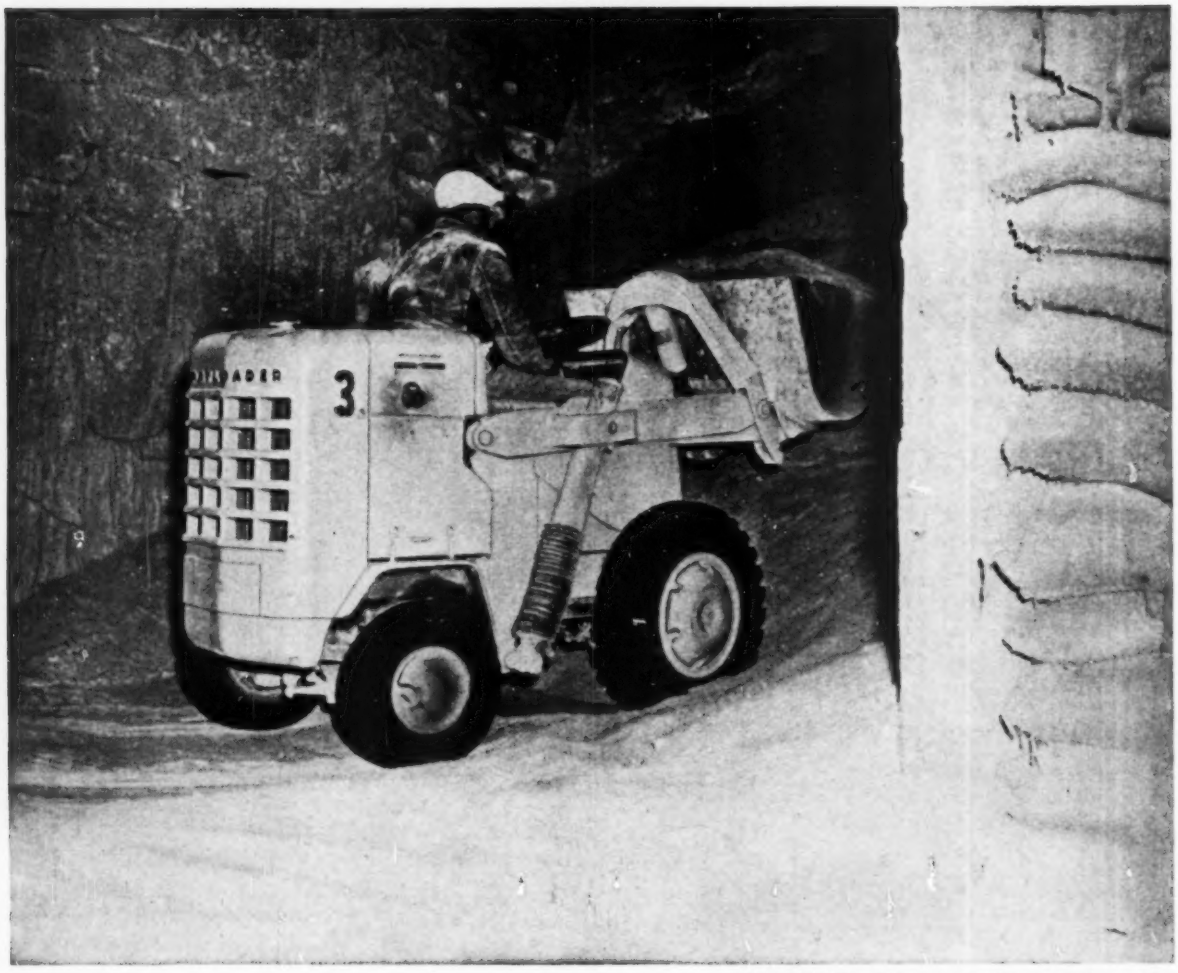
OTHER VICKERS DOUBLE PUMPS FOR MOBILE EQUIPMENT

(Left) Series V-4200 Double Pump in 6 sizes from 30.7 to 70.2 gpm combined delivery.

(Right) Series V-5200 Double Pump in 6 sizes from 48.8 to 89.4 gpm combined delivery.

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

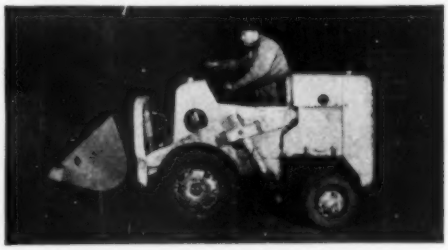
U. S. Rubber Multi-Flex Boots make equipment last longer



Note Multi-Flex Boot extended from ram plunger that lifts 12 cu. ft. bucket. The ram plunger activates the bucket to any position required for loading or unloading stone, cinders, sand.

The hydraulic actuating pistons on many types of equipment such as the tractor-shovel (above) and lift trucks are protected by Multi-Flex Boots. Made without molds by a versatile process developed by United States Rubber Company, they can do many jobs conventional boots cannot do. Multi-Flex Boots prevent scoring of pistons and damage to packing by stones, sand, cinders and other materials. They also protect against rust and corrosion.

The versatility of rubber seems to have no limits when in the hands of "U.S." technicians. They may be able to make your product last longer, or operate more economically. Write to address below.



Here the Multi-Flex Boot is compressed. The drive wheels throw quantities of stones against the boot at high velocity.

U.S. RUBBER
SERVING THROUGH SCIENCE

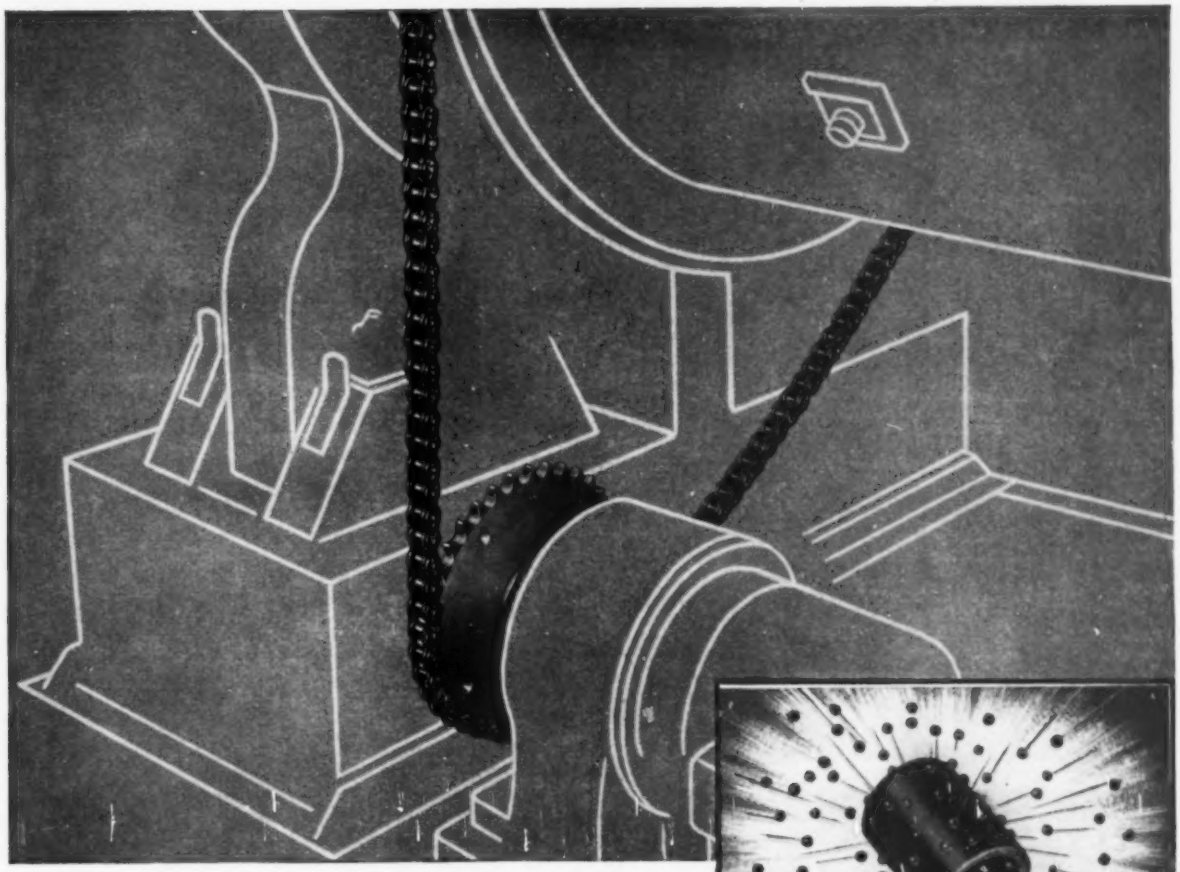
"U.S." Research perfects it..."U.S." Production builds it...U.S. Industry depends on it.

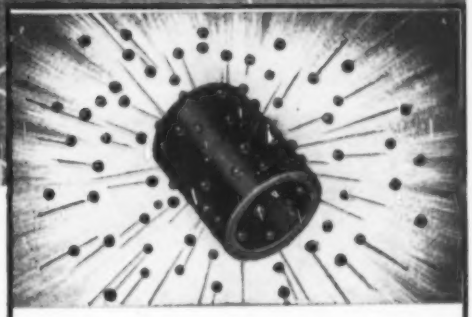
UNITED STATES RUBBER COMPANY

MECHANICAL GOODS DIVISION · ROCKEFELLER CENTER, NEW YORK 20, N. Y.

Hose • Belting • Expansion Joints • Rubber-to-metal Products • Oil Field Specialties • Plastic Products • Molded and Extruded Goods • Protective Linings and Coatings • Grinding Wheels • Packings • Tapes • Conductive Rubber • Adhesives • Roll Coverings • Mats and Matting

There's EXTRA LIFE built into LINK-BELT roller chain





Look for the distinguishing darkened rollers. Thousands of tiny steel balls hammer the metal—"cold work" each roller . . . pay off in extra fatigue life . . . added ability to withstand shock and impact of today's heavier loads.

13,119-A

Shot-peened rollers are just one of many engineering extras you get from LINK-BELT

WHETHER it's for drive or conveyor service, every Link-Belt Roller Chain gives you a performance bonus. In addition to shot-peened rollers, lock-type bushings multiply capacity to withstand shock loading. And closer heat-treat control, rigid testing and thorough inspection pay off in greater uniformity . . . extra years of life. Link-Belt Precision Steel Roller Chain is built in single or multiple widths, 3/8" through 3" pitch. Double pitch 1" through 3". A call to your nearby Link-Belt office will bring you prompt, expert service. Send for Engineering Data Book No. 2457.

LINK-BELT

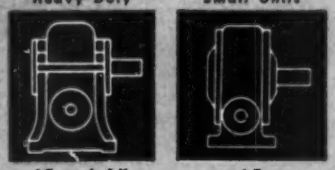
ROLLER CHAIN & SPROCKETS

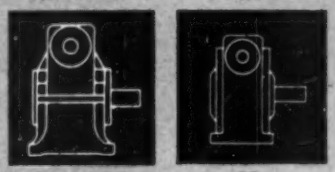
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

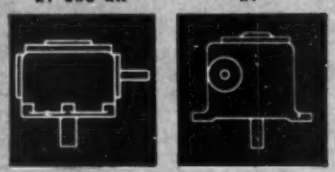
You can TAKE YOUR CHOICE

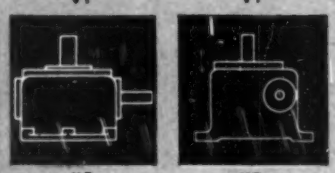
SINGLE REDUCTION

Heavy Duty | Small Units









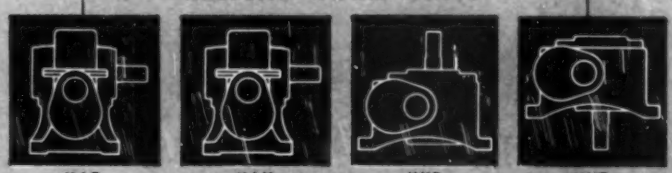
. . . they're all Philadelphia Worm Gear Speed Reducers

Philadelphia Worm Gear Speed Reducers vary in size and arrangement, but never in quality. Each unit is backed by 60 years of gear making experience and our reputation for the best in power transmission equipment.

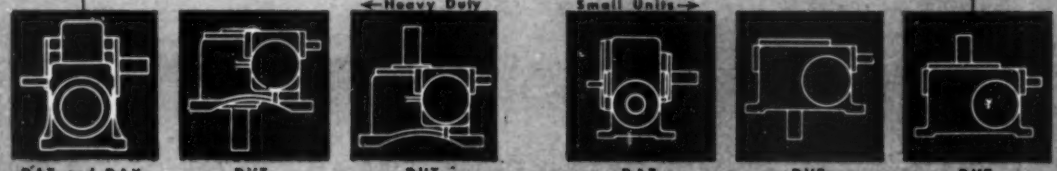
Standard worm gear reducers are available in ratings to 250 horsepower, and ratios 3½:1 to 6300:1.

For full information on Worm Gear Speed Reducers, write for catalog WG51.

HELICAL WORM UNITS



DOUBLE REDUCTION



Philadelphia Gear Works, INC.

ERIE AVE. AND G ST., PHILADELPHIA 34, PA.

NEW YORK · PITTSBURGH · CHICAGO · HOUSTON · LYNCHBURG, VA.

Industrial Gears and Speed Reducers
LimiTorque Valve Controls

Try this TEST of your IMAGINATION

Formed insulator fabricated from Spaulding Vulcanized Fibre

Look at your product . . . picture where Spaulding Products could fit in . . .

Here's a real challenge to your imagination.

Spaulding Products offer the greatest variety of mechanical, electrical and chemical property combinations found in any line of basic materials. Although now used in virtually every field of manufacture, resourceful designers, engineers and material buyers are finding new applications for Spaulding Products every day.

You can do this too.

Take any combination of properties inherent in Spaulding Products. For example, ***electrical insulation*** combined with ***arc resistance, deionizing properties, structural strength, toughness, resistance to wear*** and ***abrasion, good forming*** and ***clean punching***. A manufacturer in the electrical field will visualize at once the many component parts for his products requiring all or a part of this unique combination of properties.

For other Spaulding property combinations applicable to ***your*** business, consult the new Spaulding Handbook. Just ask your nearest branch sales office or mail coupon today for your free copy.

SPAULDING PRODUCTS FOR INDUSTRY

VULCANIZED FIBRE: In sheets, rods, tubes and fabricated parts.

ARMITE: Thin insulation (Fish Paper) in sheets, rolls, coils and fabricated parts.

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SPAULDO: Motor Insulation in sheets, rolls, coils, slot cells and other fabricated parts.

SPAULDING FIBRE BOARD: In sheets and fabricated parts.

SPAULDING T BOARD: A superior Transformer Board, in sheets and fabricated parts.

MATERIAL HANDLING EQUIPMENT: Factory trucks, Boxes, Barrels, Trays, etc.

SPAULDING FABRICATING FACILITIES

Spaulding's fabricating facilities for these products are unsurpassed the world over. You can save time and money by letting us do your fabrication. We'll be glad to quote on specific jobs without obligation to you.

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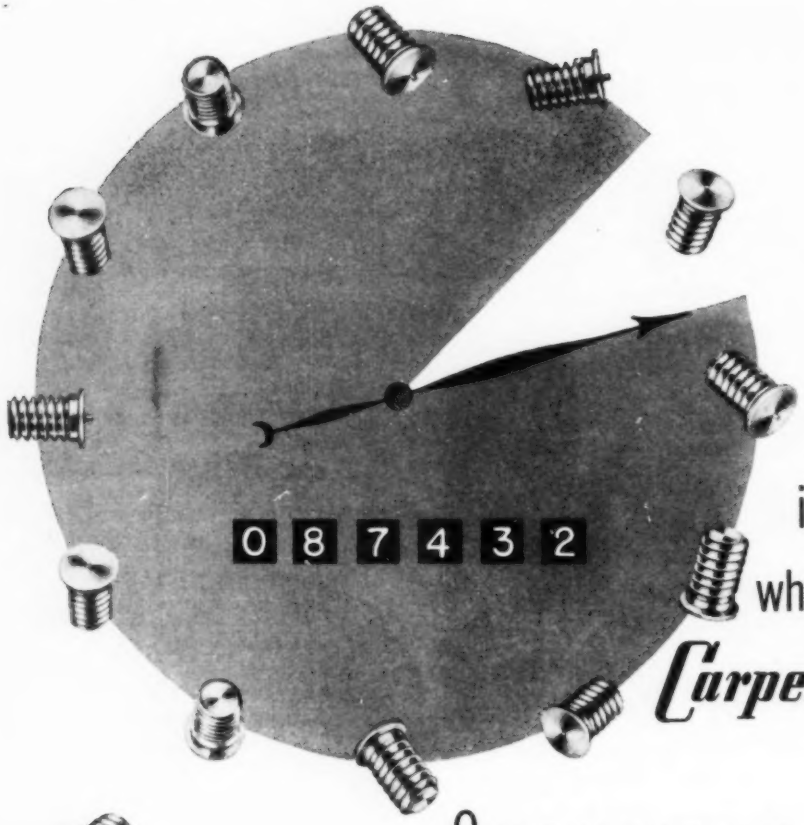
PE-2



You can run a job in less time when you use *Carpenter* stainless!

On job after job, plants like yours have found the secret of faster, trouble-free production of Stainless parts. The job shown here is an example. Again, it proves that not all free-machining stainless steels of the same type number are alike. And that's the big reason why more and more specifications come through marked "Carpenter Free-Machining Stainless." For Carpenter Stainless comes to you with a famous pedigree . . . it originates in the Mill that invented the first free-machining Stainless. And ever since, this same pioneering leadership has been concentrated on improving the workability and uniformity of stainless steels. Results: fewer rejects, better finishes, higher spindle speeds, reasonable fabricating costs.

Even in these times when many nickel-bearing grades of stainless may be hard to get because of Government Regulations, Carpenter's program of stainless research and development goes on at a steady pace. Now and in the future you can continue to count on Carpenter for Stainless you can use to run a job in less time, at a lower cost. THE CARPENTER STEEL COMPANY, 117 W. Bern St., Reading, Pa.

These studs for securing hinges to dishwashers were turned out faster when the change was made from an ordinary Type 303 Stainless to Carpenter No. 8, Type 303. The customer reports: "Because of higher output and fewer rejects we can produce each stud at a 25% saving . . . and get a far superior finish!"

Export Department: The Carpenter Steel Co., Port Washington, N. Y.—"CARSTEELCO"

Carpenter STEEL

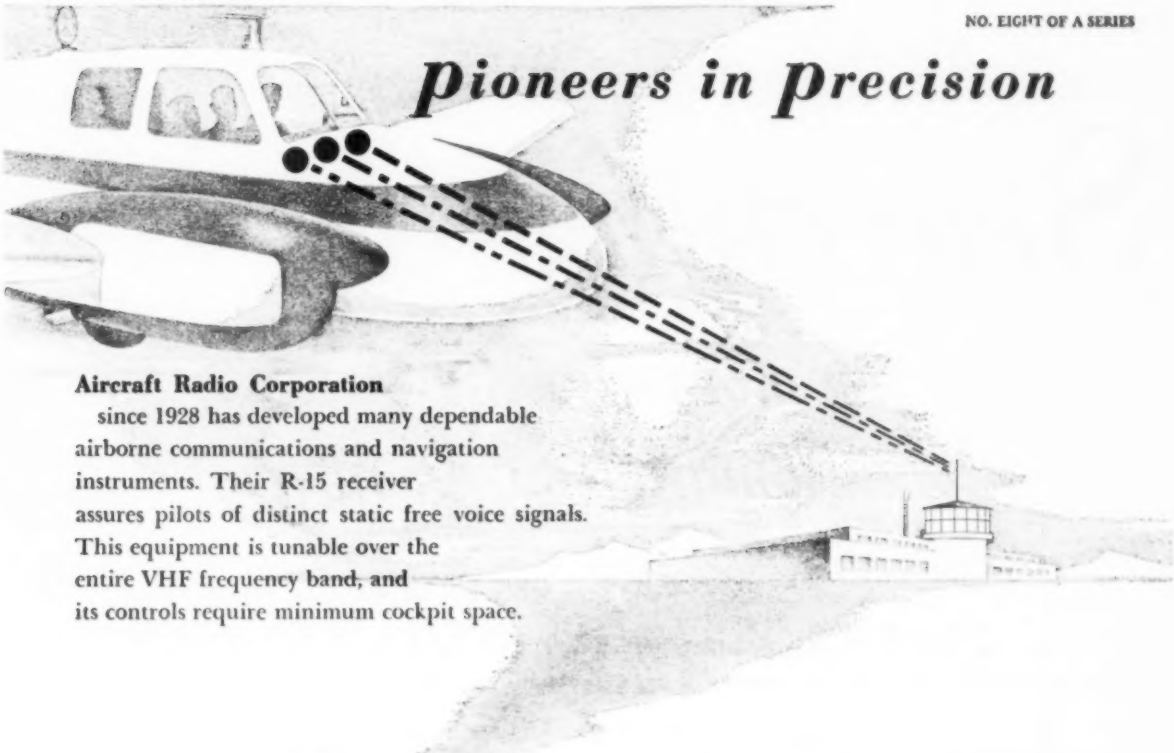
Free-Machining Stainless

takes the problems out of production

Call your nearest Carpenter Mill-Branch Warehouse, Office or Distributor

NO. EIGHT OF A SERIES

Pioneers in Precision



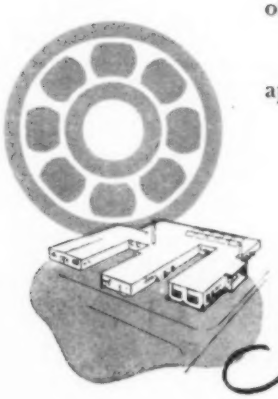
Aircraft Radio Corporation
since 1928 has developed many dependable airborne communications and navigation instruments. Their R-15 receiver assures pilots of distinct static free voice signals. This equipment is tunable over the entire VHF frequency band, and its controls require minimum cockpit space.

Miniature Precision Bearings

contribute the precise operational characteristics necessary to efficient instrument function under unusual operating conditions. This R-15 receiver is designed for long, trouble-free operation under extremes of humidity, temperature and vibration. Similar and other unusual problems present in thousands of vital equipment designs are being solved with **MPB** ball bearings.

More than a million **MPB** ball bearings have been installed in many unusual and distinctive devices. Originators and pioneer developers of ball bearings in this size range (1/10" to 5/16" O.D.), **MPB** has, for more than twenty years, supplied ultra quality bearings to discriminating users. Exclusive and exacting production and inspection procedures assure the type of quality ball bearing which permits installation in control and recording instruments of highest possible performance standards.

The most extensive engineering knowledge in miniature ball bearing application is available to you — as well as catalog and survey sheet **PE4**



Continued expansion in production facilities has enabled us to enlarge the scope of service to our clientele. We would welcome the opportunity of including you.

Miniature *precision* Bearings
Incorporated MPB Keene, New Hampshire

"pioneer precisionists to the World's foremost instrument Manufacturers"

save
space
weight
friction

Searching

for more effective automatic control instruments?

Ketay's knowledge and experience will be helpful.

It was gained in developing and designing dozens of the precision control instruments that are today's military standards.

Take Ketay's Size 23 Synchro, for instance. This single development is an integral component in the controlling of the Skysweeper . . . the Army's latest automatic antiaircraft gun. Ketay's mass production techniques are making such controls economically practical.

Our instrument engineers, with more than 25 years of specialization in this field, could well put an end to your search for more effective automatic controls. There's no obligation, of course. Why not write for more information to Dept. K.

• NEWEST KETAY PRODUCT

SUBMINIATURE TYPE
1O1A2D SYNCHRO
CONTROL TRANSFORMER

Ketay Part No.	D—14450
Voltage rating	11.8v/0.4 v per deg.
Operating frequency	400 cps
Input power	0.4 w max.
Input current	140 ma max.
Input impedance	61 /77° ohms
Secondary voltage	23.2 ± 1 v
Total null voltage	40 mv max.
Fundamental Component of Null voltage	30 mv max.
Time Phase Shift	7°
Moment of Inertia	8.8 × 10^{-5} slug in^2
Frictional Torque	.05 oz. in.
Electrical Accuracy	—max. 10′

WHEN USED AS A
CONTROL TRANSMITTER

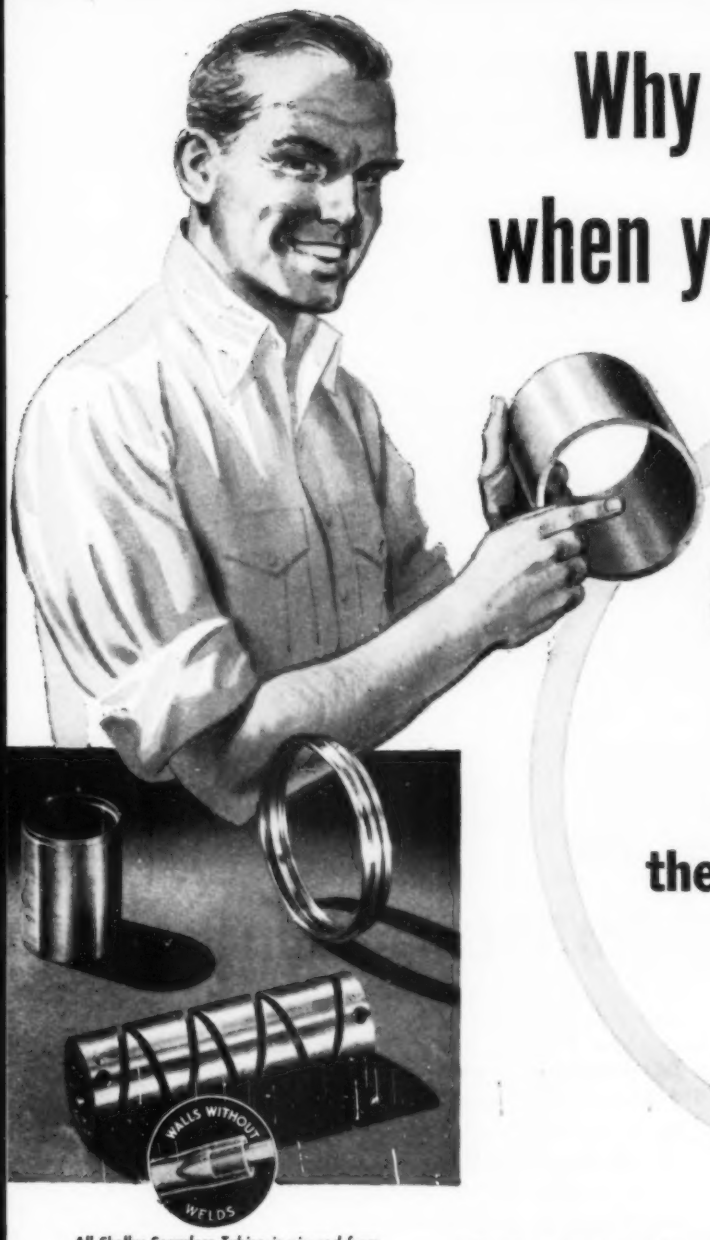
Voltage rating	26/11.8 v.a.c.
Input power	0.4 w max.
Input current	65 ma max.
Input impedance	475 /77° ohms
Output voltage	11.8 v ± 0.3 v
Time phase shift	7.3°

Ketay MANUFACTURING CORP.
New York, N.Y. Hawthorne, Calif.
Executive Offices: 555 Broadway, New York 12, N. Y.

DESIGN
DEVELOPMENT
MANUFACTURE *of precision instruments*

• SYNCHROS • SERVOS • RESOLVERS
• MAGNETIC AMPLIFIERS • AUTOMATIC CONTROL SYSTEMS
• ELECTRONIC EQUIPMENT

Why bore a hole when you can buy it?



SHELBY SEAMLESS STEEL TUBING

comes to you with the hole and basic shape already made!

All Shelby Seamless Tubing is pierced from solid billets of uniform steel. This is the one manufacturing method that assures absolute uniform wall strength.

THIS FREE BOOK

tells how you can cut production cost and make better parts. Write for it today!

● It costs money to bore a hole through solid stock. It takes time. It wears out tools. It wastes steel. In other words, it's poor economy.

By using Shelby Seamless Mechanical Tubing you can eliminate or greatly reduce many time and labor consuming operations connected with boring and machining.

Shelby Seamless Tubing is available in a complete range of sizes; in different wall thicknesses; various finishes and steel analyses . . . with the basic shape already made . . . and with the hole built in.

Another important advantage in using Shelby Tubing is that its excellent machining characteristics and uniformity speed up production and improve the quality of your output. You can turn out parts by the millions and the last part will be as metallurgically and dimensionally accurate as the first.

Why not talk to National's engineers about the economic advantages of using Shelby Seamless Tubing? You can be sure that any recommendations they make will be based on a thorough study of your particular requirements.

NATIONAL TUBE DIVISION, UNITED STATES STEEL CORPORATION, PITTSBURGH, PA.
(Tubing Specialties)
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S SHELBY SEAMLESS MECHANICAL TUBING

UNITED STATES STEEL

- Stampings, not castings
- Welded for strength
- Easily adapted to most power units
- Air-cooled—Oil cooler can be added
- Leak-proof construction
- Low-cost manufacturing

Long Torque Converter for INDUSTRIAL and AUTOMOTIVE applications

New design and manufacturing methods permit us to combine top performance and low cost in Long torque converters. Already in high-volume production for passenger car use, they can be readily modified to many industrial applications. Eleven and 12-inch diameters cover a range of engines from 90 to 200 pounds-feet torque, depending upon nature of service. With torque ratios at stall of 2.1 to 1 and efficiencies over 90%, they should simplify many power transmission problems. We are prepared to extend the engineering cooperation required to insure a satisfactory installation. Your inquiries are invited.

LONG MANUFACTURING DIVISION • BORG-WARNER CORP. • DETROIT, MICH. AND WINDSOR, ONT.

50 Years of Quality Manufacturing for the Automotive Industry

LONG

A PRODUCT OF BW BORG-WARNER

TORQUE CONVERTERS • CLUTCHES • RADIATORS • OIL COOLERS

NATIONAL OIL SEAL LOGBOOK

Reprints from this or other Logbook pages are available for your files. Request them from our Redwood City, California office

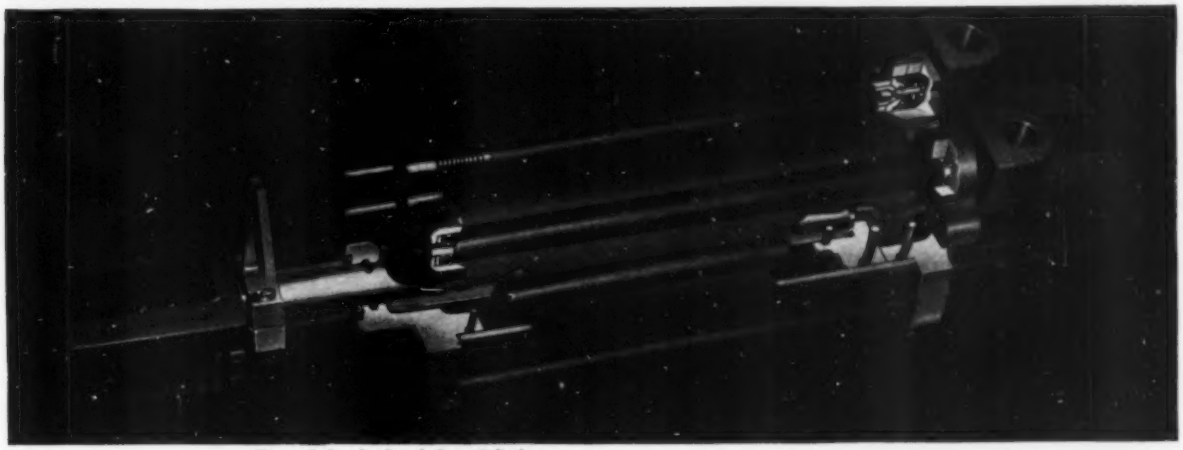


Figure 1. Bendix Depth Stop Cylinder

Ten O-Rings, Oil Seal solve pressure and dirt problems in compact Bendix Depth Stop Cylinder

The 3½" x 8" Depth Stop Cylinder is one of a line of cylinders manufactured by Bendix Pacific Division for the agricultural trade. Designed specifically for the operation of tractor-drawn tools, this cylinder has proven sufficiently rugged to be used for the operation of dozer blades, scrapers, etc. Operating conditions require sealing at ten points. Ten-O-Rings plus a rod wiper (oil seal) are used.

Bendix specifications provide that with the piston extended and 1,000 p.s.i. at one main port, there shall be no leakage at the opposite port. Also, with the poppet rod compressed and 300 p.s.i. at one port, leaks at the opposite port shall not exceed 7 c.c. in the last minute of a four-minute period.

This high order of sealing is achieved by the use of precision-made National O-Rings in both dynamic and static applications (Figure 1). O-Ring sizes vary from ½" to 3½" O.D. Dynamic applications are all of the reciprocating type, and S.A.E. #10 oil is used in the system.

Where the piston rod passes through the cylinder head, a National 340,000 Syntech* oil seal is installed to exclude heavy concentrations of dirt, dust and mud. This seal has a synthetic rubber sealing member of springless design, bonded to a rigid steel inner member. The seal O.D. is also rubber covered to provide a positive seal against the cylinder head bore. (Figure 2)

National O-Rings and the seal used in this assembly are all standard units available without special engineering. National offers a complete line of quality O-Rings and over 2,500 standard-design oil seals. Whether your sealing problem requires special engineering or can be met with standard National sealing devices, National Applications Engineers are at your service. Call the nearest National office for information.

Figure 2. National 340,000 Syntech

Trade Mark Registered

Sealing News & Tips

National 30,000 series Seals

Have a heavy-duty sealing problem involving lubricant retention and dirt exclusion? Investigate National 30,000 series leather seals. Impregnated spring-loaded sealing lip retains grease or oil; tough springless outer wiper excludes foreign matter. Steel outer case press fits into bore or housing.

National O-Ring Catalog

Includes engineering, design and compound data, gland groove and back-up ring requirements, practical engineering suggestions. Lists all National O-Rings. Request free copy on letterhead, giving position or title.

"Let Your Decision be Based on Precision"

NATIONAL
OIL & GREASE SEALS
O-RINGS SHIMS

NATIONAL MOTOR BEARING CO., INC.
General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

2880

CALL IN A NATIONAL APPLICATIONS ENGINEER

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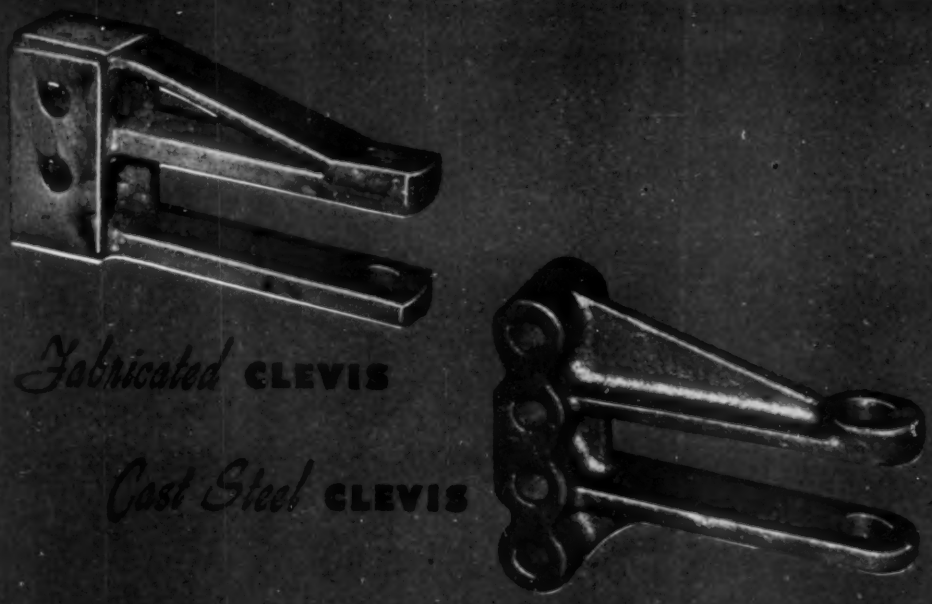
PRODUCT DESIGN STUDIES • NO. 46



Serviceability Improved, Cost Reduced by Redesigning To A Steel Casting.

This part, called a "clevis", is used on a rather newly developed tractor-drawn implement for introducing nitrogen into the soil. It connects implement and tractor.

When produced as a weldment, the clevis failed to meet several important service requirements. To overcome these deficiencies would have added considerably to the cost.

Redesign of the part to a steel casting resulted from collaboration between the steel foundry and implement manufacturer. Costing less than the original weldment, the steel casting provided greatly improved serviceability and eye appeal—important because the clevis is fully exposed.

* * *

Here is another example of the foundry cooperation which is resulting in lower costs and improved products through redesign to steel castings.

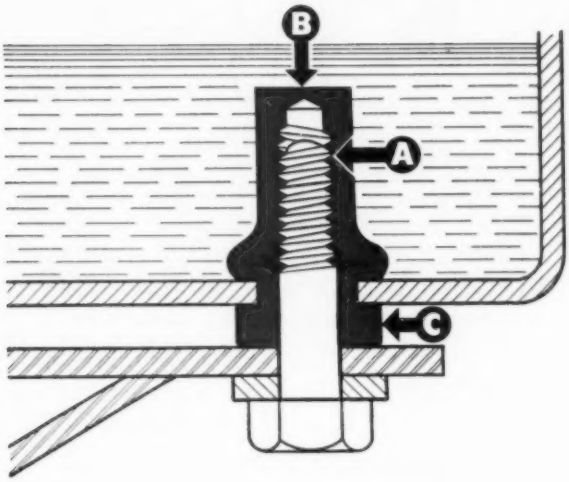
This service is offered without cost or obligation. It makes available through your foundry representative the full results of the development and research program carried on by the Steel Founders' Society of America.

50 YEARS OF SERVICE TO INDUSTRY

STEEL FOUNDERS' SOCIETY OF AMERICA
920 Midland Building — Cleveland 15, Ohio

Design and Build With Steel Castings

RIVNUT replaces nut plate on oil tank . . . eliminates leaking, warping, thread cleaning



A MANUFACTURER of industrial oilers was brazing nut plates on his reservoir tanks for bolting to brackets. This sometimes caused leaks and warping. Since painting had to follow brazing, the threads had to be retapped.

By switching to Rivnuts, brazing was eliminated. Installed from one side, after painting, in one-tenth the time required for brazing, Rivnuts provide at least six clean threads (A) to take the attachment bolt. Rivnut forms oil-tight seal, has closed end (B). Special spacer head (C) of Rivnut forms uniform height feet.

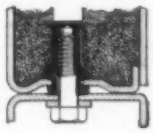
Closed-end Rivnut with spacer head is one of many types of Rivnuts. If you have a fastening problem, consult a Rivnut engineer. Write to The B. F. Goodrich Company, Dept. A-19, Akron, Ohio.

What's your toughest fastening problem?

TORQUE?

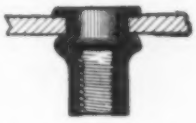
Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?



Even in thin materials, Rivnuts provide at least 6 threads for attachment.

ATTACHMENT?

Fasten *with* Rivnuts—fasten *to* Rivnuts. Makes possible multiple fastening.

FINISH?

Rivnuts can be installed after finish, such as paint or porcelain, is applied.

LOAD?

Typical Rivnut thread strength: 6-32—964 lbs.; 8-32—1096 lbs.; 10-32—1326 lbs.*

RIVNUTS *lick them all!*

***Figures given for aluminum. Loads for brass and steel Rivnuts about double.*

B.F.Goodrich

RIVNUTS

The only one-piece blind rivet with threads

SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department A-19, Akron, Ohio.

We've been solving automatic control problems for 38 years

Controlling guided missiles in flight

Knowing your whereabouts under all circumstances

Stabilizing the guns on bouncing tanks

Shooting down jet planes from the unstable decks of ships

Hitting inland targets from battleships

Take one part of the fantastic, mix thoroughly with Ford's engineering and production ability, and you've got the answer to another "impossible" automatic control problem. That has been the sum and substance of the Ford Instrument Company since 1915.

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From the more than 16 acres of floor space that make up the engineering and production facilities of the Ford Instrument Company, come the mechanical, hydraulic, electro-mechanical and electronic instruments that bring us our "tomorrows" today! Research, development, design and production are being applied to control problems of both Industry and the Military.

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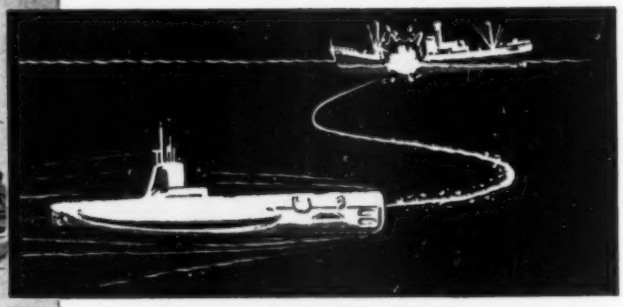
DIVISION OF THE SPERRY CORPORATION
31-10 Thomson Avenue, Long Island City 1, N. Y.



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technical bulletin

WEIGHT ↓

POWER ↑

WEIGHT ↓

Greater output per pound is the constant objective of the aircraft designer. EEMCO serves this goal by turning out new electric motors with increased power, decreased weight and all the required operating characteristics. This tough new lightweight for driving a compressor was built to the latest Army and Navy specifications. Operating on 27 volts D.C., it provides 3 horsepower under continuous duty at sea level, 2½ h.p. at 50,000 feet with duty cycle of ½ hour on—½ hour off. It weighs only 13½ pounds with integral gear box of 2¾ to 1 reduction.

Doubled plant capacity and new facilities enable EEMCO to keep pace with the growing need for these specialized designs. Today EEMCO motors and actuators are found on virtually all U. S. Aircraft.

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Six Big Benefits Obtained from DIE CASTING

CASE HISTORIES FROM MT. VERNON FILES

Here's what Burn-Rite Products Co., of Yonkers, N. Y., makers of Burn-Rite oil burners, says: "We find that as a result of switching to die casting, we profit by the following:

1. Product weight held down to minimum—permitting substantial freight savings. (Formerly, 87 lbs., now weighs 75 lbs.)
2. Greater ease of assembly—due to decrease in weight of parts.
3. Savings due to accuracy of die casting, which reduces cost of tooling, machining, and handling.
4. Smooth-surface castings which present a finer painted finish.
5. Less employee fatigue—due to easier handling of lighter parts.
6. Increased production *without* additional increase in help.

To these six big advantages, you can add a seventh: Mount Vernon's Complete Four-fold Service, (*a*) *consultation*—to help with design and production problems; (*b*) *die making*—on modern tool and die equipment handled by skilled personnel; (*c*) *castings*—guaranteed "on grade" at all times; (*d*) *machining facilities*—for handling every machining operation castings may require.

A switch to die casting may profit you tremendously, too. Why not consult with us?

MT. VERNON
DIE CASTING CORP.
MT VERNON NEW YORK

just the right VERTICAL drive for every job!

On agitator tanks—on mixing vats—on overhead conveyors—on beaters—wherever the application calls for a vertical drive, you will find just the right one for your needs in the wide range of drives available from Foote Bros. Capacities up to 264 h.p. Ratios from 4⅛ to 1 up to 4118 to 1.

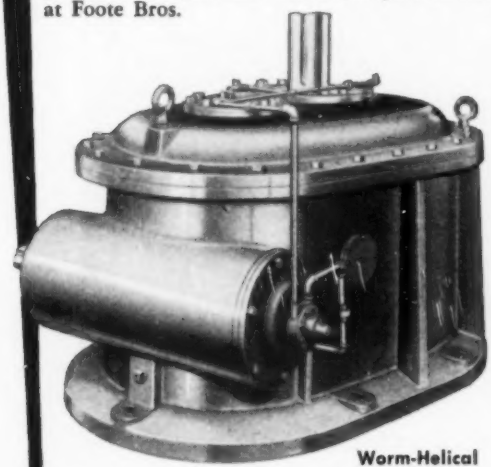
Line-O-Power Drives—compact, efficient drives with Duti-Rated Gears available in standard models or in extended shaft design where long unsupported output shafts are encountered.

Foote Bros.-Louis Allis Gearmotors in vertical design.

Hygrade Worm Gear Drives standard design or Hytop design for long, unsupported output shaft extensions.

Worm-Helical Gear Drives. Big, husky units of worm and helical gear design.

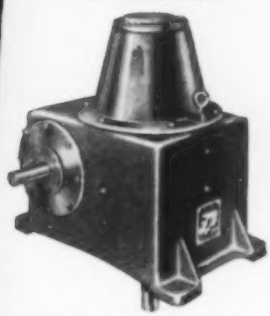
Whatever your requirements in vertical drives, you will find just the one to suit your needs at Foote Bros.



Worm-Helical Gear Drive

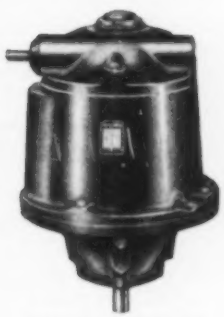
Foote Bros.-Louis Allis Gearmotor Extended Shaft

Hygrade Worm Gear Drive Standard Shaft



Hygrade Worm Gear Drive Extended Shaft

Line-O-Power Drive Standard Shaft



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Better Power Transmission Through Better Gears

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- ☐ Foote Bros.-Louis Allis Gearmotors
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Company.....

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Position.....

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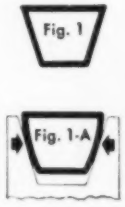
WHY
Gates V-Belts Wear Longer-

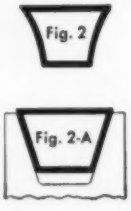
The CONCAVE SIDE (U.S. Patent No. 1813698) is what gives the Extra Wear!

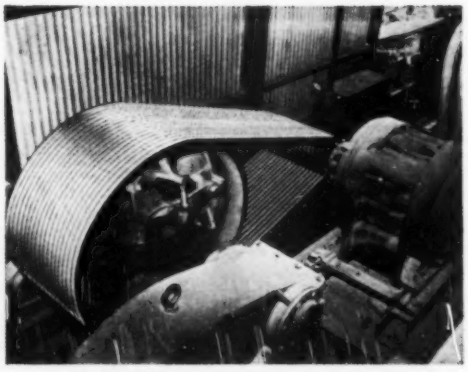
Take any *straight-sided* V-Belt (Fig. 1) and bend it as it bends in going around its pulley. You will clearly see its sides *bulge out* (Fig. 1-A). These sides therefore press *unevenly* against the V-pulley and this causes extra wear at the point shown by arrows (Fig. 1-A).



Now bend a Gates Vulco Rope with CONCAVE SIDES (Fig. 2).

You will see the precisely engineered CONCAVE SIDES fill out to an exact fit in the sheave-groove (Fig. 2-A). The sides press *evenly* against the V-pulley. All wear is distributed *uniformly* across the *full width* of the Gates Vulco Rope—and this means longer belt *life* and *lower* belt *costs* for you.





Typical Gates Vulco Rope Drive—the Gates V-Belts are built with Concave Sides to insure longer belt wear.

When you buy V-Belts, be sure to get the V-Belt with the CONCAVE SIDES—the Gates Vulco Rope!

Gates Engineering Offices and Jobber Stocks are located in all industrial centers of the United States and in 71 foreign countries.

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V-Belts—Hose
Molded Rubber Goods
for Industry
World's Largest Maker
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Gates® VULCO ROPE DRIVES

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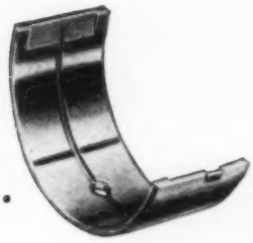
Sleeve bearings . . .  more than 50 years specialized experience. Research, design, quality control, quantity production. Widest range of sizes and lining alloys on bronze or steel backs. Complete engineering service. Long or short runs for automotive and industrial requirements.

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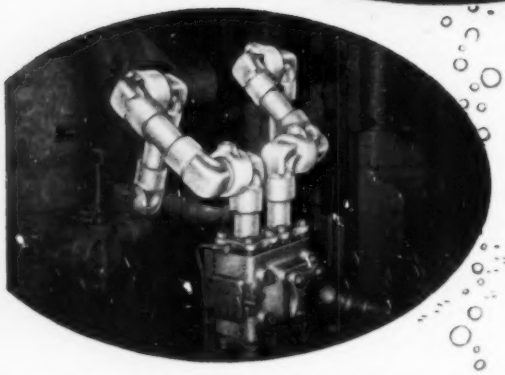
11043 SHOEMAKER, DETROIT 13, MICH.

Sleeve bearings in all designs and sizes • Cast bronze bushings • Rolled split-type bushings Bimetal rolled bushings Washers • Spacer tubes • Precision bronze parts • Bronze bars

FEDERAL Mogul SINCE 1889

FEDERAL-MOGUL

Safety of its people and property, plus increased efficiency and economy of operation, were the chief considerations which turned Johnson Motors to Chiksan Swivel Joints.



Chiksan ball-bearing swivel joints installed on Lester-Phoenix die-casting machine helped Johnson Motors meet its fluid cost problems.

Johnson Motors die-casting department, one of the largest in the Middle West — and the largest captive plant in this country — selected Chiksan hydraulic swivel joints when it converted its machines from flammable oils to nonflammable hydraulic fluids.

Forty-eight package die casting machines are operated on a staggered three shift basis, producing more than 400 aluminum alloy die castings ranging from ½ ounce to 11 pounds in size. Hydraulic systems are operated at pressures up to 2000 psi, with average total die forces in the range of 300 to 500 tons. Castings are made at temperatures between 1100° and 1200° F.

Chiksan ball-bearing swivel joints have helped to reduce fluid losses from 40,000 gallons per year to 10,000 gallons. In contrast to former loss of from 1 to 3 gallons in repositioning bolted lines, Chiksan joints permit resetting of table level with virtually no fluid loss. Time consumed in resetting table levels has been reduced from 2 men and 1 hour to one man and 15 minutes of time.

This story is typical of the many ways thousands of manufacturers are using Chiksan ball-bearing swivel joints for greater safety, efficiency, and economy in their operations.

For Safety, Economy and Efficiency in your die casting department Chiksan has plans and applications worthy of your immediate and serious consideration.

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Ball-Bearing Swivel Joints

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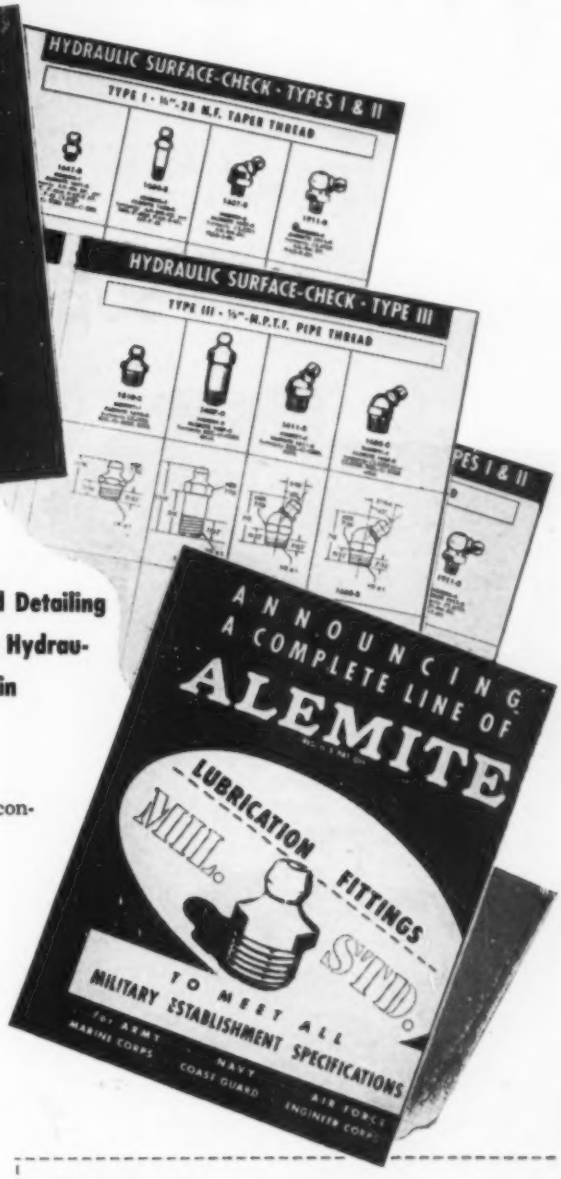

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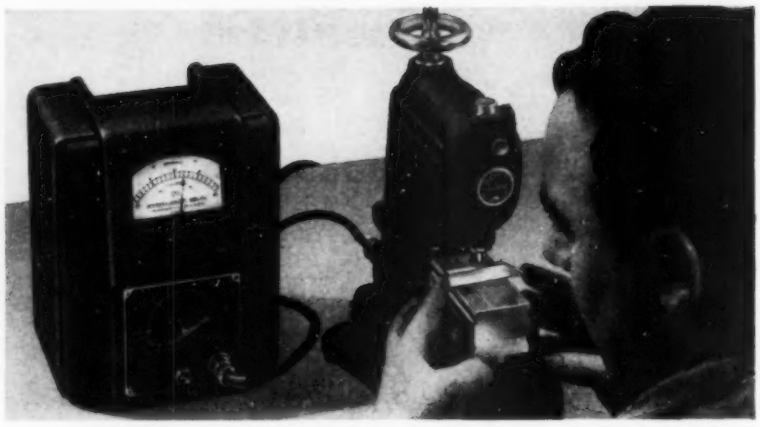

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High vacuum pumps for laboratory, electronic, atomic research, biological and other chemical processing, vacuum refining of metals, de-aerating, dehydration, vacuum drying, refrigeration, etc.

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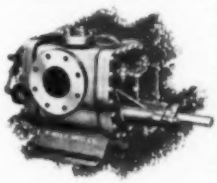

A complete range of sizes in Rotating Plunger and Herringbone Gear Pumps to handle light or heavy liquids, sludges, slurries or viscous substances. Available in plain or steam jacketed models and built of special corrosion resistant metals where desired.

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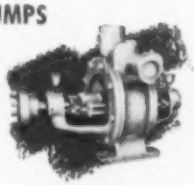
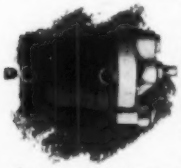
Deep well, sump, drainage and condensation return units, household water systems. Industrial low and high pressure liquid handling pumps. Direct motor and countershaft driven horizontal and vertical models. Capacities 3 to 7500 gpm.



STRATOPOWER PISTON TYPE PUMPS



Axial reciprocating piston type . . . constant or variable delivery with capacities of .25 to 10 gpm at nominal speeds of 1500 rmp with maximum of 4500 rmp . . . working pressures to 3000 psi . . . direct engine and individual electric motor driven models.

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- ☐ Stratopower Pumps
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- ☐ Dudco Pumps
- ☐ Aurora Pumps

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Heavy Duty Needle Bearings

for maximum performance

Outstanding service over the years has won for TORRINGTON Heavy Duty Needle Bearings the confidence of machinery builders and users in every major industry.

Today you will find these rugged TORRINGTON Bearings giving free-rolling, low-maintenance service in equipment ranging from traveling cranes to rolling mills, oil well pumping units to machine tools, printing presses to auxiliary paper-machine equipment.

6 reasons why TORRINGTON *Heavy Duty* Needle Bearings will serve you better...

1 The one-piece outer race and inner race are manufactured from carburizing-grade nickel steel. Harder surfaces offer better resistance to wear; tough cores stand up under shock.

2 Their accurately ground raceway and side flange surfaces eliminate drag at the point of roller contact. Rollers operate in a true path.

3 The stainless steel retaining bands are spot welded into position. They give positive roller retention and form an internal lubricant reservoir while resisting the entry of foreign matter to the rolling elements.

4 The lubrication groove in the outer race and oil holes in both inner and outer races permit easy, effective lubrication from a drilled hole in the housing.

5 The large-fillet trunnion ends increase roller strength and present to the ground, well-lubricated side flanges a larger, more wear-resistant area.

6 Full complement of rollers assures maximum load carrying capacity.

Specify TORRINGTON Heavy Duty Needle Bearings!

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON HEAVY DUTY NEEDLE **BEARINGS**

Spherical Roller • Needle • Tapered Roller • Straight Roller • Ball • Needle Rollers

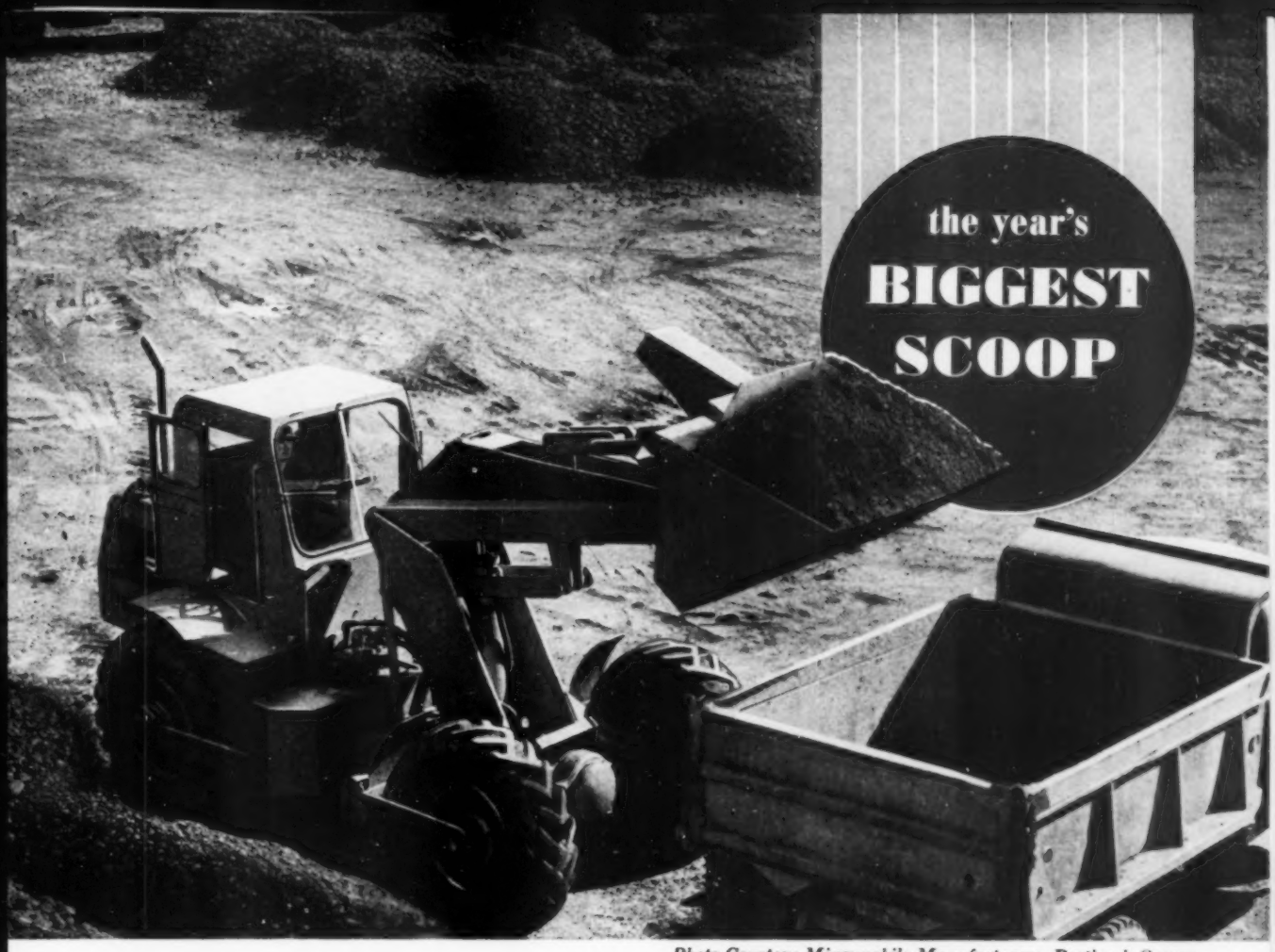

Photo Courtesy Mixermobile Manufacturers, Portland, Oregon

180 horsepowered Scoopmobile loads 4319 yards of wet sand in 31 hours!

No stranger to hard work, this loader. Each time it bends down, a hydraulically operated loading bucket picks up, carries and loads as much as two cubic yards of dirt, rock or sand. Four-wheel planetary gear drive and four-wheel power steering are combined for plenty of power, amazing speed and maneuverability. Five-speed transmission enables top performance under any conditions of terrain.

Like others, this manufacturer powers with Chrysler because he *knows* every Chrysler Engine is engineered for long-lived, top-profit performance. He selected the husky Model 20 Chrysler V-8 Industrial Engine. Result: *more* work in *less* time.

Chrysler can equip its 180 horsepower Model 20, or any of its Industrial Engines, to meet special requirements. For example, Chrysler can supply engines with propane or natural-gas burning carburetor, gyrol Fluid Coupling or torque converter.

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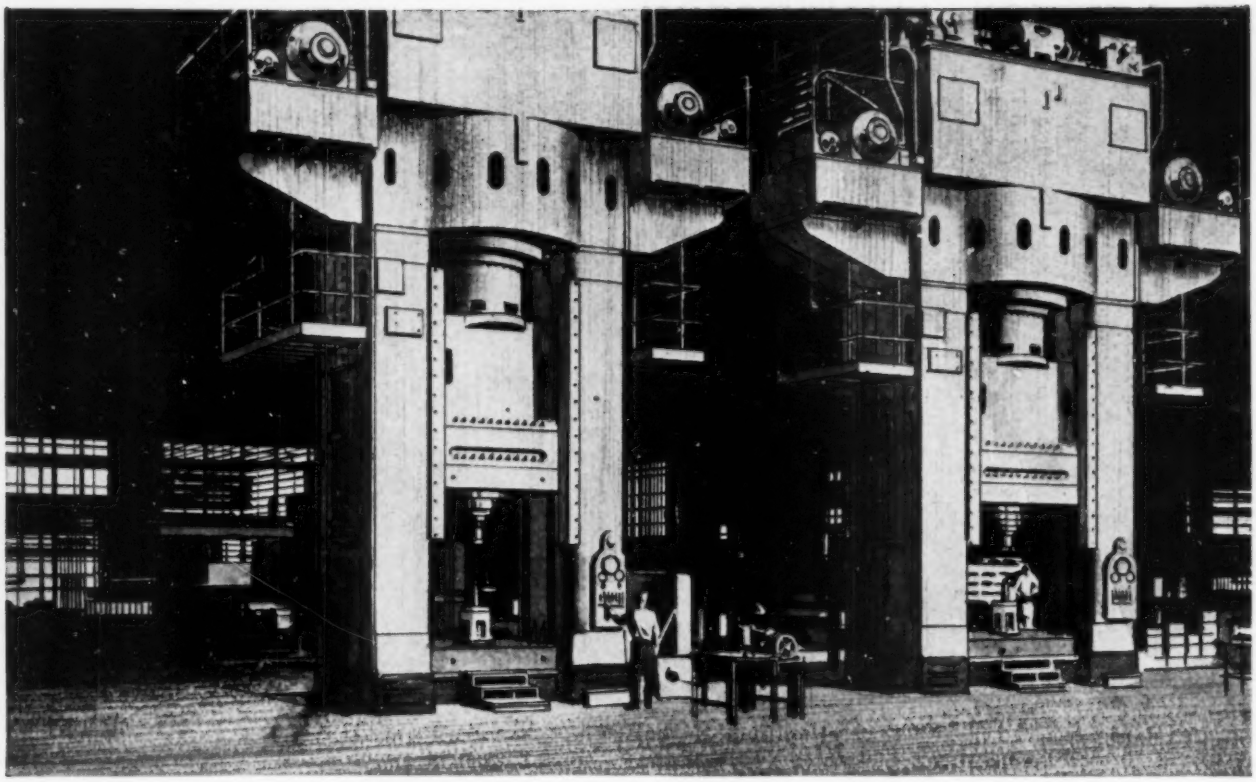
Industrial Engines

HORSEPOWER WITH A PEDIGREE



World's first commercial facilities for producing parts by exclusive Mullins Steel *Koldflo* Process

Commercial facilities supported by specialized engineering and development departments are now available to industry for the production of parts by the exclusive Mullins Steel KOLDFLO* Process.

Now for the first time the economies of this process which shapes cold steel into finished parts is made available to American industry.

The Mullins Steel KOLDFLO Process is completely and exclusively different from any other extrusion process. The finished products come from the presses with smoothness, hardness, strength and precision required, and all of these features are acquired in the process from the use of low carbon, low cost steel.

The process can better and more economically make a wide variety of finished products. Some of these products have already been produced and are shown on the opposite page. They are used in many different fields of manufacture.

The new and expanded facilities for commercial use make possible the production of cold-formed, hollow parts into finished shapes and a wide variety of configurations and are in lengths from 6″ to 36″ and in diameters from 2″ to 6″.

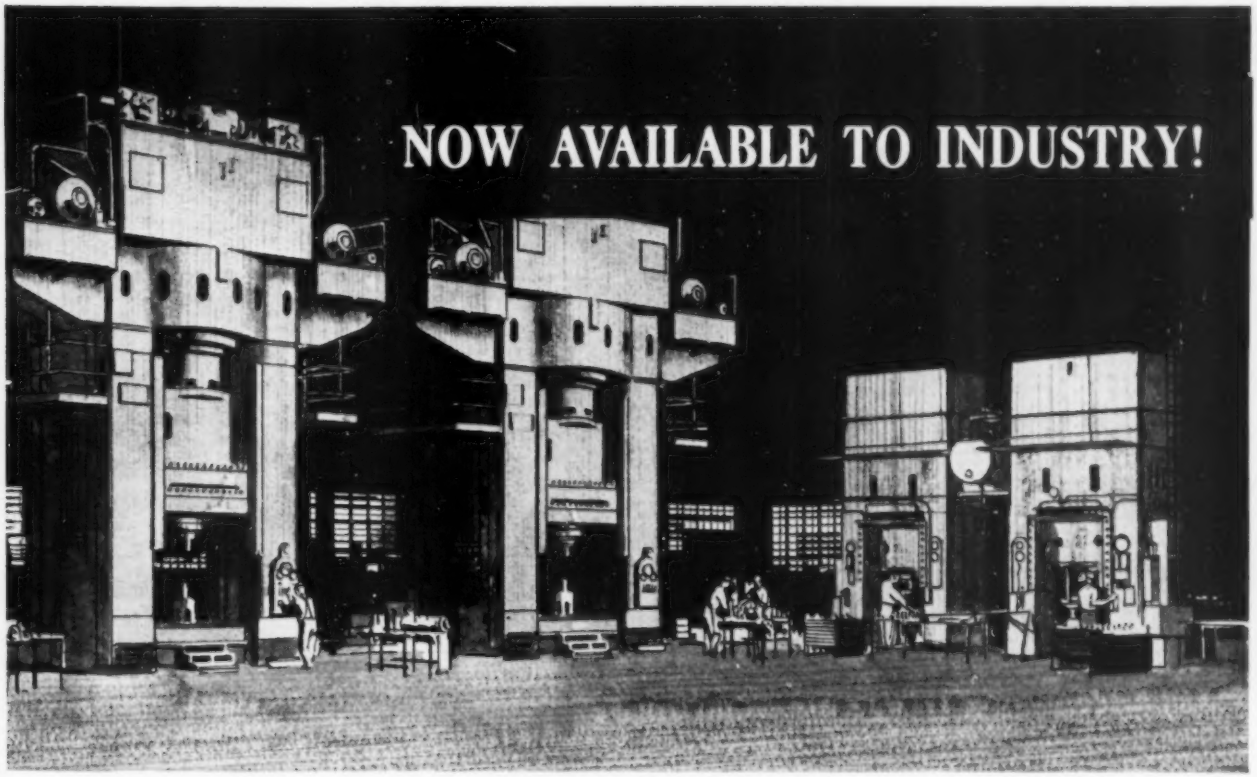
Because the Mullins Steel KOLDFLO Process is so new, the question "What is KOLDFLO?" has been asked us many times. To answer this question, we have prepared a booklet entitled **"Product Design Guide."**

This Design Guide will be valuable to executives, engineers and designers in studying the cost-saving possibilities of this process.

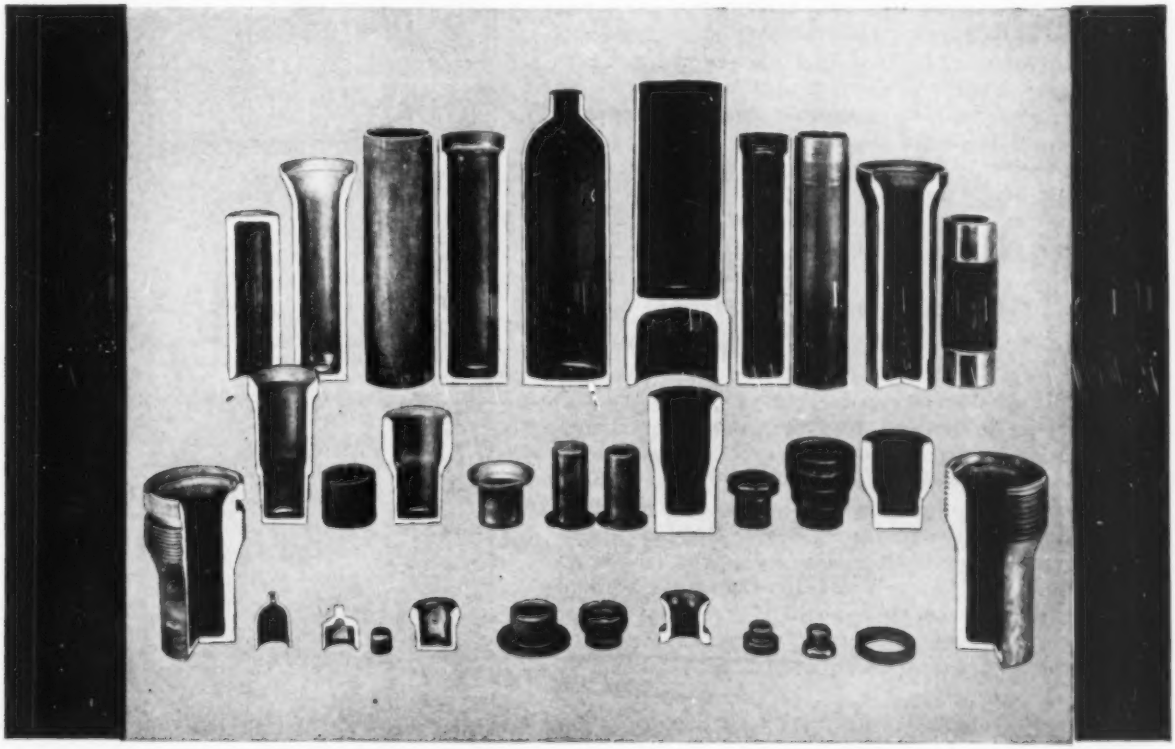
Koldflo Division
MULLINS MANUFACTURING CORPORATION
SALEM, OHIO

*KOLDFLO is a trade-mark of Mullins Manufacturing Corporation.

Send today for your free copy of "Product Design Guide."

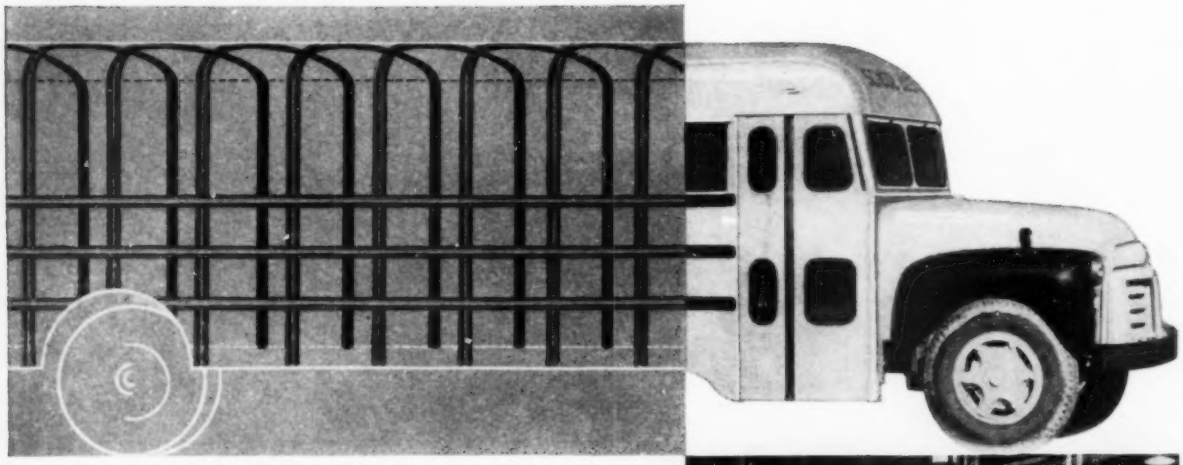


These six giant presses are the beginning of the Mullins Steel KOLDFLO commercial production facilities.



These parts have already been produced and hundreds of other similar parts can be produced by the Mullins Steel KOLDFLO Process with a definite savings in steel, manpower, machine tools, plant space and dollars.

Here's How a Manufacturer of Bus Bodies Uses *Cold-Formed Shapes*



Two sturdy Bethlehem Cold-Formed Shapes are being used by a leading manufacturer of school-bus bodies. One Cold-Formed Shape is used for the post and carline section that provides the necessary rigid body construction of the bus. The other is used for the guard molding on the exterior of the body, giving an additional—and vital—safety factor. Both shapes are formed from sheet-gage steel.

This manufacturer saves valuable shop time by using Bethlehem Cold-Formed Shapes, because they are supplied to exact dimensions, without any waste material, and they are easy to bend, form and assemble. They are relatively free of scale, rust and roughness, and virtually no hand labor is necessary to prepare them for welding.

Cold-Formed Shapes in *Your* Product

It's a good bet that you can use Cold-Formed Shapes in your product, no matter what you manufacture. The applications of these shapes are almost limitless—lately we've made them for use in overhead door track, ornamental railings, lawn furniture, storage racks, and industrial conveyor systems, to name only a few. And Bethlehem Cold-Formed Shapes come in any gage of strip, sheet or plate steel, from 5 to 24. A rough sketch will enable our engineers to determine whether we can make a practical and economical product for you.

Why not write for our booklet on Cold-Formed Shapes, or better still, have our representative visit your shop and go over your operations with you. Just contact the nearest Bethlehem sales office, or write to us directly at Bethlehem, Pa.

Post sections made from Bethlehem Cold-Formed Shapes need only bending and punching to become the rigid ribs of a future school bus.

Exterior guard molding, another Bethlehem Cold-Formed Shape, is easy to install and gives an additional safety factor to the bus body.

BETHLEHEM STEEL

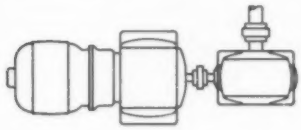
BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

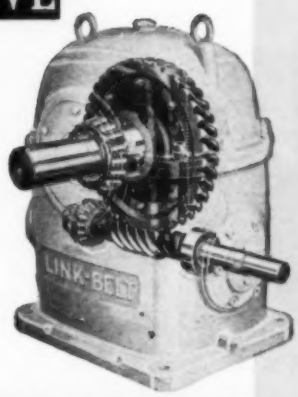
On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

How to change even complex speed reduction problems into *simple* ones

WORM GEAR DRIVE

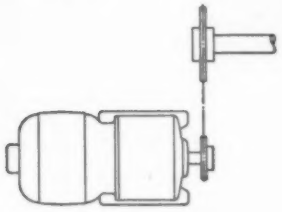
WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios—1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324A.





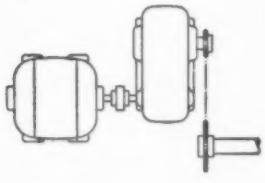
GEARMOTOR & HELICAL GEAR DRIVE

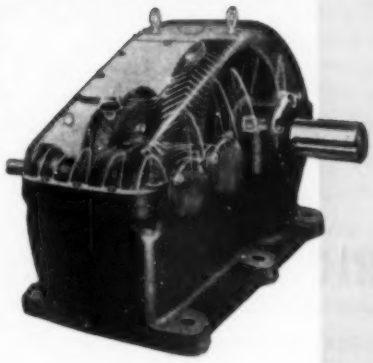
GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios—1 to 30 hp—6 to 280 output shaft rpm. Ask for Books 2247 and 2451.



HERRINGBONE GEAR DRIVE

HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain take-off. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios—0.4 to 2480 hp—2.2 to 623 output shaft rpm. Ask for Book 2519.





Get the proper drive combination that best meets your requirements from the broad LINK-BELT line

In addition to matching a wide range of requirements for ratio, hp, loading conditions and similar factors—Link-Belt enclosed gear drives offer you other benefits. When your Link-Belt representative selects a helical, herringbone or worm gear drive, you have no worries about coordinating it with your other components.

For Link-Belt builds a complete power transmission line. There's no need to exchange drawings with a third person to calculate chain, sprocket, coupling, bearing or even shafting requirements. You can get all these from one source . . . each pre-engineered for perfect fit.

Next time you're faced with a speed reduction problem, take it to power transmission headquarters. There's a Link-Belt sales office near you. Call today for complete engineering information.

LINK-BELT

ENCLOSED GEAR DRIVES

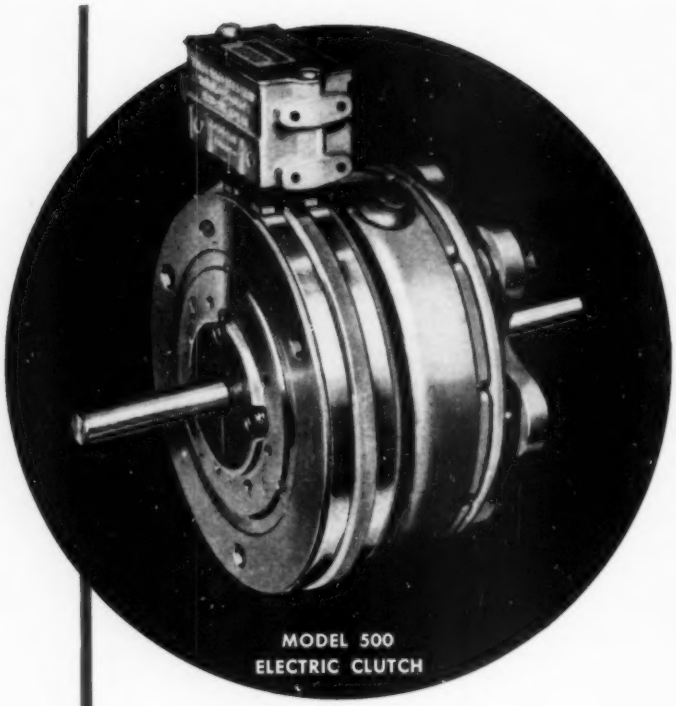
LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities.

13.120-A

Precise control builds satisfied users of Seybold paper cutter with new Warner Electric Clutch

WARNER
electric motion control

- **reduces maintenance—eliminates shock to machinery**
- **safeguards man and machine—accurate within .001"**
- **increases production—eliminates down-time**
- **replaces manual effort and skill—positions paper automatically**



MODEL 500
ELECTRIC CLUTCH

It's easy to operate the improved Series "Sixty" Power Paper Cutter. Movement of the back gauge through a *high speed* and *creep* cycle is precisely controlled by two instant-operating Warner Electric Clutches. In fact, stops are so precise—within .001"—the machine cuts faster, more accurately, with less manual effort and skill!

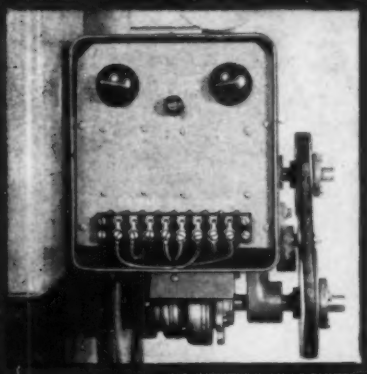
In replacing positive-tooth clutches, the Warner friction-type units not only improve performance greatly, they cut maintenance costs, eliminate down-time for servicing solenoids, and reduce wear and tear on other machine parts. While the clutch operation is lightning-fast, there's no shock or *clashing* from the smooth, *cushioned* electro-magnetic engagement.

Users of the improved Seybold "Sixty" are enthusiatic about the performance of Warner *electric motion control*. Perhaps your machine operations—involving speed control, braking, clutching, indexing, rapid cycling, tensioning, synchronizing, or coupling—may be similarly improved with only minor design changes. Your Warner Representative will show you how!

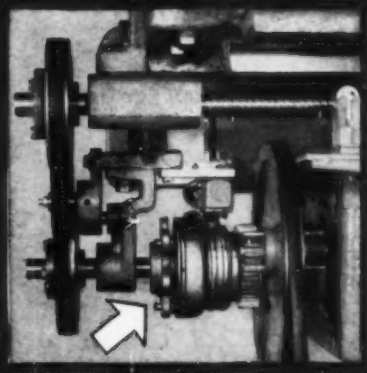
WARNER

ELECTRIC BRAKES & CLUTCHES

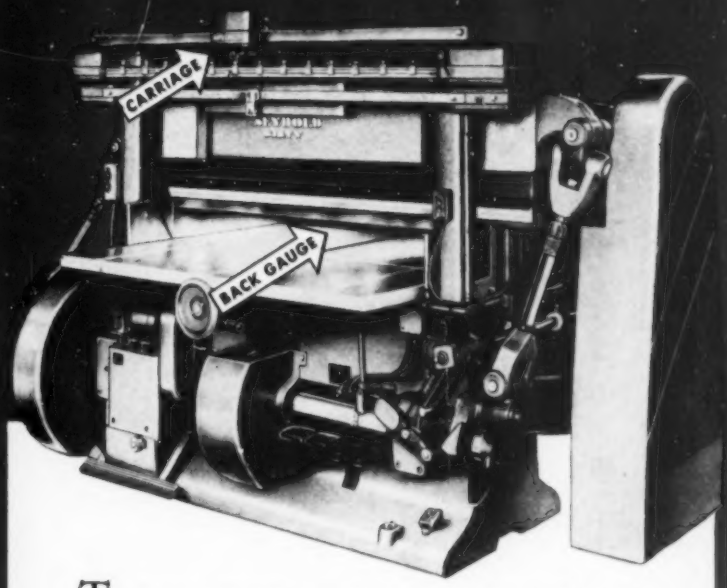
FOR INDUSTRIAL APPLICATION



Warner Controller includes rheostats for adjusting torque and speed of each clutch, and relay for automatic switching from high to creep drive speeds.



Power from the main drive motor is transmitted through the Warner Electric Clutch, mounted on through-shaft, to lead screw driving the back gauge.



The Series "Sixty" Auto-Spacer, manufactured by the Harris-Seybold Co., Dayton, Ohio, cuts paper to exact lengths and widths. As the carriage travels along the spacer bar, it actuates the Warner Electric Clutch, engaging the back gauge *high speed* drive. When carriage contacts the stop dog, a second Warner Electric Clutch engages the *creep speed* before the paper is positioned for cutting. As the knife returns from the cut, the paper is automatically and precisely positioned for the next cutting cycle.

EQUIPPED WITH WARNER *electric motion control*

Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for their small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric eyes, pushbuttons, etc. Rate of application is accurately controlled to synchronize motions—give exact degree of speed and power required for your machine operation.

CONTROL ENGINEERING SERVICE . . . Warner offers complete application and control engineering service and field assistance. If you have a clutching, braking, tensioning, indexing, or speed-control problem, consult experienced Warner brake and clutch specialists for reliable recommendations on torque, heat, electrical controls, capacity, etc.

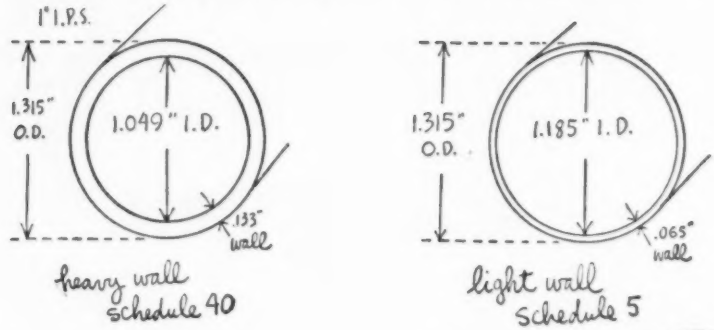
AMERICAN MANAGEMENT ASSOCIATION
TWENTY-SECOND
national packaging exposition
APRIL 20-23 1953
NAVY PIER · CHICAGO

VISIT WARNER'S BOOTH
See *electric motion control* in action, booth No. 194, at the packaging exposition in Chicago. Paste coupon to letterhead or postal card and mail today for new catalog.

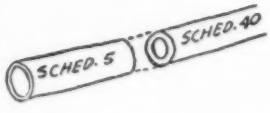
Warner Electric Brake & Clutch Co., Dept. PE, Beloit, Wis.
☐ Please send your **FREE** Bulletin, WEB 6069.
☐ Would like to see working demonstration.

Firm Name_____
Individual_____ Title_____
Address_____
City_____ State_____

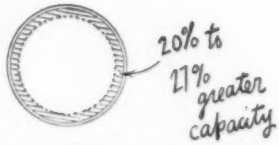
here's what you gain with stainless schedule 5 pipe



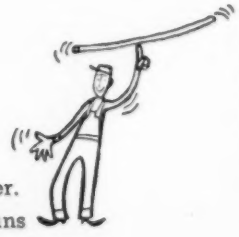
You save money. Schedule 5 pipe costs about half as much per foot as Schedule 40.



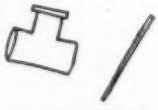
Schedule 5 has the same O.D. as Schedules 10, 40 and 80 —for hook-up with existing lines as well as for new installations.



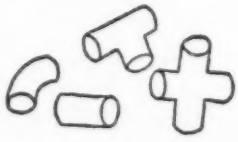
Its larger I.D. increases flow and capacity in pipelines, exchangers and other equipment.



It's lighter. This means quicker and easier installation.



You can save substantially on valves, fittings, weld rods, etc., because smaller O.D. material can frequently be used. Tubing sizes can now be replaced with light wall pipe . . . for ready hook-up with standard valves, pumps, and other equipment normally manufactured in pipe sizes.

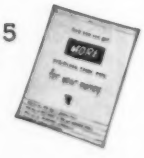


Fittings as well as stocks of Schedule 5 pipe are carried by conveniently located Carpenter distributors.

Specify Schedule 5 pipe . . . it saves dollars . . . and makes a lot of sense!

THE CARPENTER STEEL COMPANY
Alloy Tube Division, Union, N. J.
Export Dept : The Carpenter Steel Co., Port Washington, N.Y. "CARSTEELCO"

Data Sheets give you complete information about Carpenter Schedule 5 Stainless Pipe. Write for your personal copy.



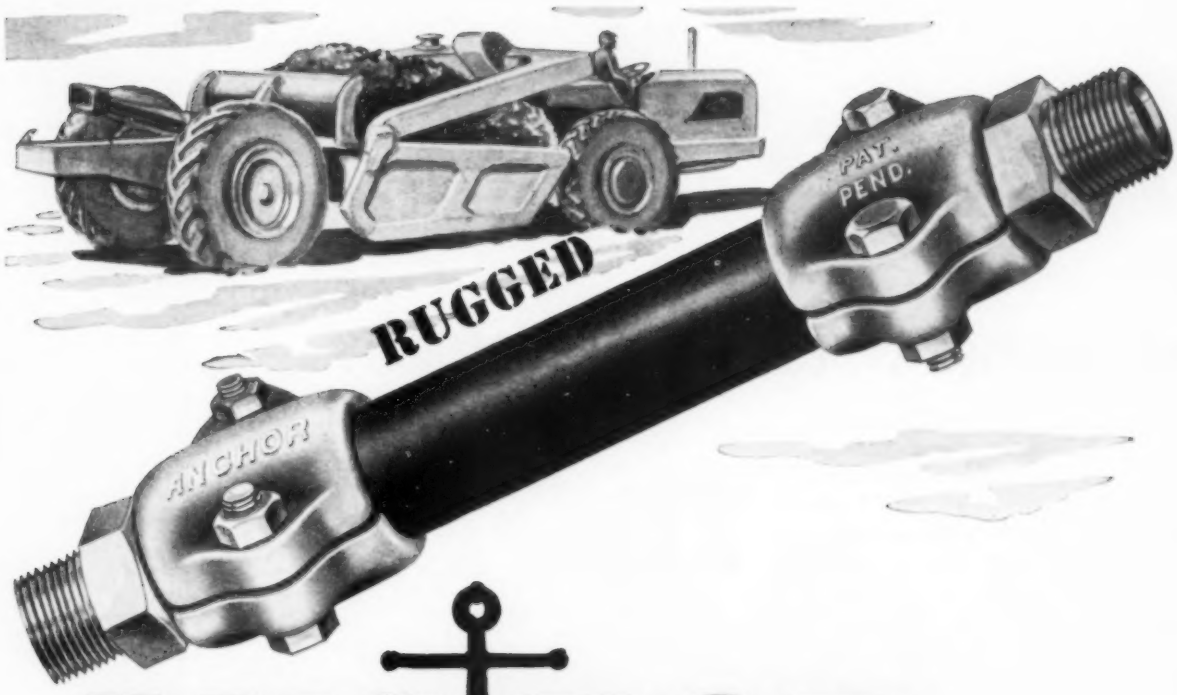
THE U.S. NEEDS YOUR STEEL SCRAP NOW

Carpenter

STAINLESS TUBING & PIPE

Analysis — Tolerance — Finish

• guaranteed on every shipment



ANCHOR

CLAMP-TYPE REUSABLE COUPLINGS

— ideal for heavy-duty original-equipment service or emergency repairs in the field

For high or medium pressures—can be used with one- or two-wire braid hose.

Specially designed clamping segments — impulses can't shake them loose, yet coupling is reusable again and again.

Easy to apply — no special tools needed to assemble couplings and hose. Hose cover need not be stripped to apply coupling.

Neat Installation — made possible by compact design of the Anchor clamp and the use of streamlined Anchor adapter unions and related fittings.

Saves Time — you don't have to wait for repairs because you can make up your hose lengths as needed. Stocking problem minimized.

NEW!
REVOLUTIONARY
ANCHOR
SPLIT-FLANGE CLAMP
Positive leakproof connection without threaded joints. Bolt centers are located to distribute the forces evenly and prevent tilting of the clamp halves. Easy to assemble with small automotive-type wrench.

Get more details. Attach coupon to your letterhead and mail today.

ANCHOR COUPLING CO. INC.

Main Office and Factory: LIBERTYVILLE, ILLINOIS

FACTORY BRANCHES: DETROIT, MICHIGAN • DALLAS, TEXAS

D-14

Anchor Coupling Co. Inc.
Dept. PE-4, Libertyville, Illinois

I'd like to know more about

- ☐ Anchor clamp-type reusable couplings
- ☐ New Anchor Split-flange clamp.

Send me detailed information.

Name.....**Title**.....

Company Name.....

Company Address.....

City.....(.....) **State**.....

more MANUFACTURERS

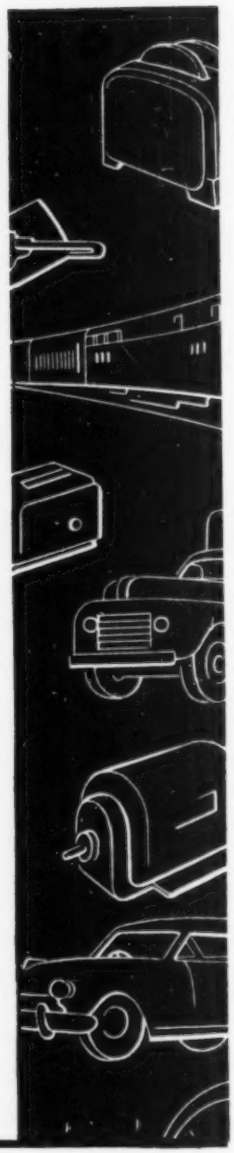
OF AMERICA'S BEST KNOWN PRODUCTS

USE more

The Original

PARKER-KALON®, SELF-TAPPING SCREWS

THAN ANY OTHER TAPPING SCREW

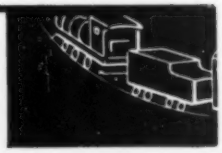


. . . . BECAUSE WITH P-K,

PLANNED SAVINGS PAY OFF

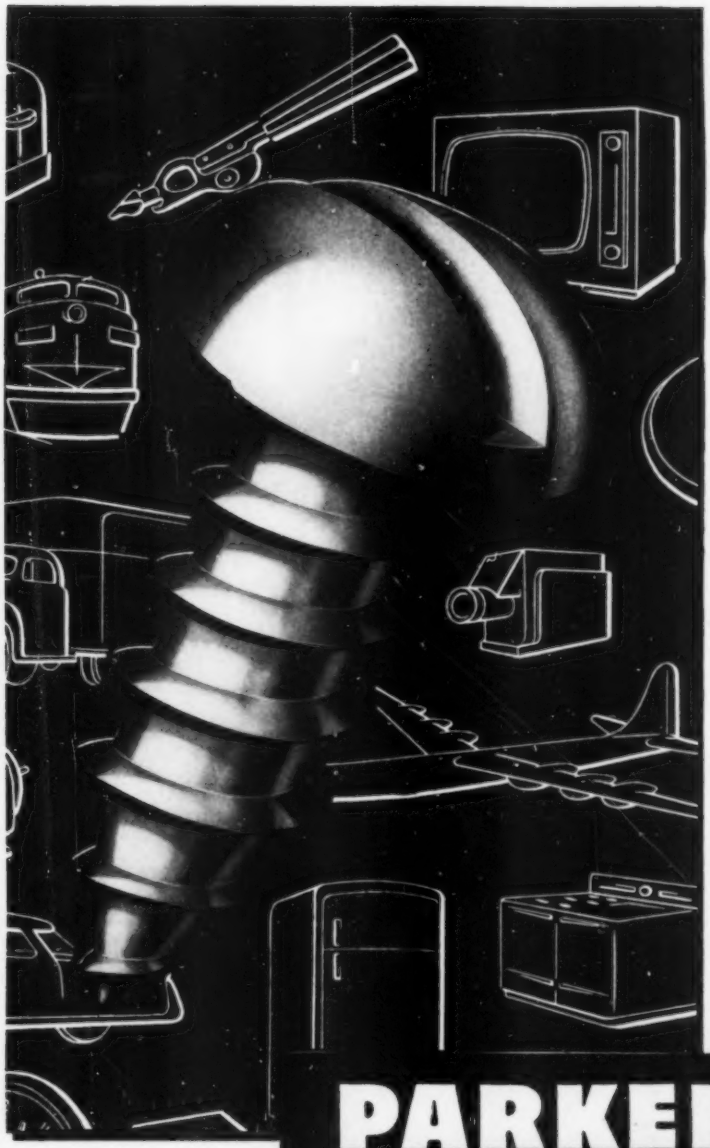
Be sure you get P-K STANDARDS in POINTS

P-K point design makes sure the screw starts right, drives right. For example, by specifying P-K you can be sure of well formed, sharp gimlet points on Type A. With sharp point, P-K Type A stays upright, even when holes are misaligned—doesn't tip like a blunt point screw. It takes an extra operation, costs more to make the right kind of gimlet point, but P-K does it to give you fast, trouble-free assembly.



ORDER from the local P-K DISTRIBUTOR . . .

the SUPPLY SPECIALIST that serves you.



WELL PLANNED IS HALF DONE

... but only half done, when you plan assembly. For screw failure can cancel all planned savings. That's why, to *insure* savings, so many fastening-wise manufacturers insist on Parker-Kalon Self-tapping Screws.

Since assembly expense is a sizable percentage of total production costs (in some products as much as 75%), they know fastening operations are a prime target for cost reduction.

Keep your assembly line trouble-free. Avoid screw failure, parts spoilage, high reclamation costs. Specify P-K Self-tapping Screws, and be *sure* planned savings pay off.

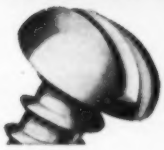
Remember

IF IT'S **P-K** IT'S O.K.

PARKER-KALON®

SELF-TAPPING SCREWS

Be sure you get P-K STANDARDS in HEADS

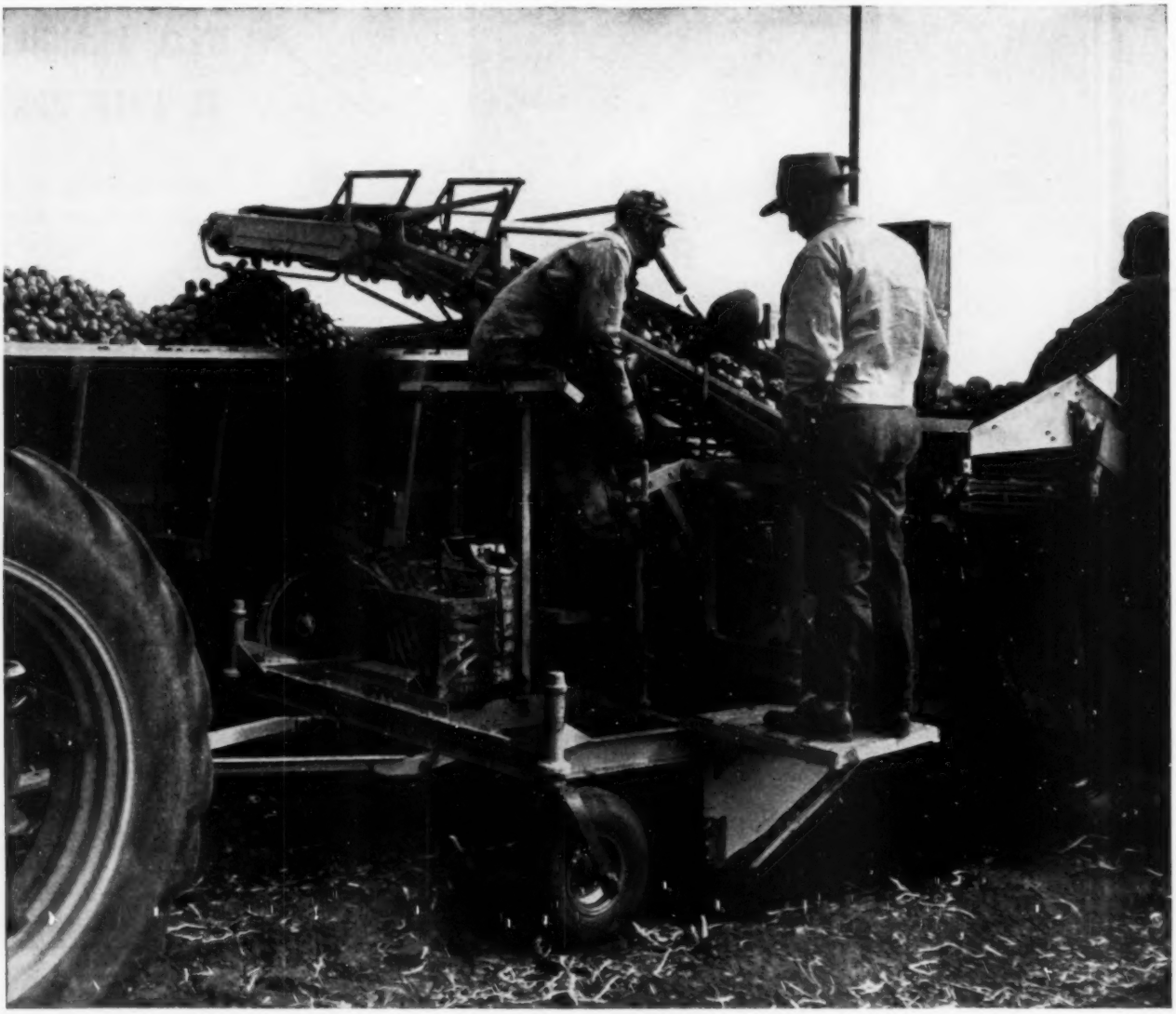


Heads on P-K Screws are all full formed to exacting P-K Standards, concentric with shank. Slots are cleaned sawed—free from burrs—not too deep to weaken head, not too shallow or narrow to prevent proper seating of driver. You have to look close to see this detail, but the difference it makes on the assembly line shows up quickly. By specifying P-K you can be *sure* of uniform, trouble-free head design in every screw.

NEW BOOKLET NOW READY

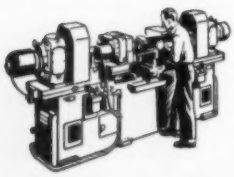
A handy guide to lower costs in assembly, filled with facts you need to start making savings you are missing. Ask your P-K Distributor, or write for Form 475-D. Parker-Kalon Corporation, 200 Varick St., N. Y. 14.

LINK-BELT ball



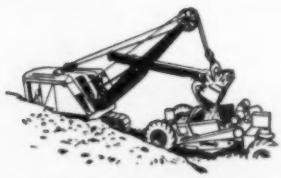
Using various Link-Belt ball bearings—pillow block, cartridge and flanged types—this potato harvester has mechanized another crop . . . Potatoes are dug, separated from vines, dirt and stones and loaded directly into trucks. Built by Champion Corp., Hammond, Ind. Other Link-Belt products specified by the designers: roller chain drives, conveyor screws, flexible couplings.

LINK-BELT ball and roller bearings

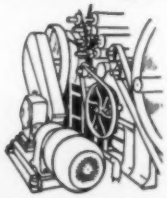


Metal Working Machinery

Farm Machinery



Construction Equipment



Textile Machines

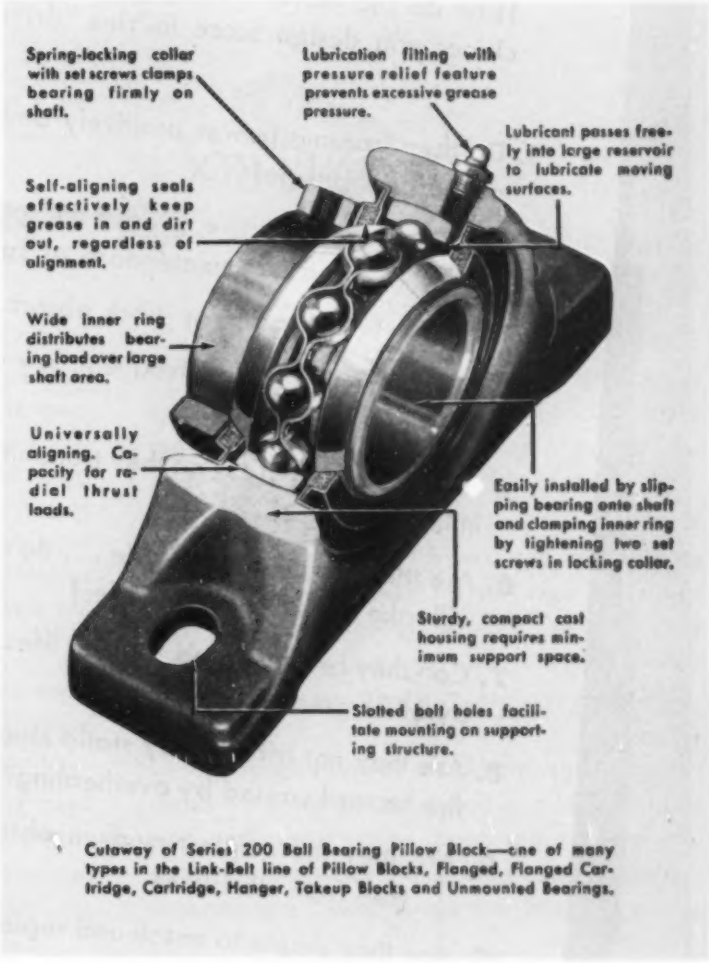
and roller bearings

keep company with America's hardest-working machines

WHERE loads are heaviest and operating conditions most severe—you can always rely on Link-Belt precision ball and roller bearings. That's why so many top equipment designers specify Link-Belt for their tough-job applications.

Thousands of installations have proved the dependability of Link-Belt bearings. Quality construction throughout—combined with precision manufacture—assures the ultimate in accuracy and long life.

There are Link-Belt ball or roller bearings to meet every industrial need. And there's a Link-Belt bearing engineer near you to help apply them to your particular requirements. You can also get all the facts from Data Book 2550.


Spring-locking collar with set screws clamps bearing firmly on shaft.
Lubrication fitting with pressure relief feature prevents excessive grease pressure.
Lubricant passes freely into large reservoir to lubricate moving surfaces.
Self-aligning seals effectively keep grease in and dirt out, regardless of alignment.
Wide inner ring distributes bearing load over large shaft area.
Universally aligning. Capacity for radial thrust loads.
Easily installed by slipping bearing onto shaft and clamping inner ring by tightening two set screws in locking collar.
Sturdy, compact cast housing requires minimum support space.
Slotted bolt holes facilitate mounting on supporting structure.

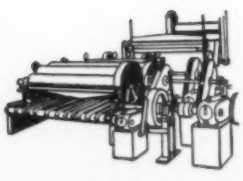
Cutaway of Series 200 Ball Bearing Pillow Block—one of many types in the Link-Belt line of Pillow Blocks, Flanged, Flanged Cartridge, Cartridge, Hanger, Takeup Blocks and Unmounted Bearings.

LINK-BELT

BALL and ROLLER BEARINGS

LINK-BELT COMPANY: Plants: Indianapolis, Chicago, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices, Factory Branch Stores and Distributors in Principal Cities. 13,111

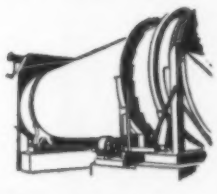
smooth the path of power for all industry



Pulp & Paper Machinery

Materials Handling Equipment

Oil Field Equipment



Processing Equipment

How Do YOU Score on

How do the drives from the power source in the machines you design score in this "driving" test?

	YES	NO
1. Do they transmit power positively and efficiently without costly slippage?	☐	☐
2. Do they assure positive, precise timing of machine operations . . . constant maintenance of speed ratios?	☐	☐
3. Do they have maximum shock absorbing ability?	☐	☐
4. Do they require only infrequent, low-cost, easy maintenance?	☐	☐
5. Are they compact . . . do they transmit large horsepower in limited space?	☐	☐
6. Are they sturdy and reliable . . . do not fail suddenly . . . will take abuse in emergencies?	☐	☐
7. Can they be lubricated for long life . . . are not affected by oil or grease?	☐	☐
8. Are they not affected by static electricity . . . free from fire hazard caused by overheating?	☐	☐
9. Are they the quietest medium obtainable in operation . . . free from vibration?	☐	☐
10. Are they simple to install and replace?	☐	☐
11. Are they long lived . . . of all-metal construction?	☐	☐
12. Do they allow for variations in shaft setting?	☐	☐
13. Are they free from pre-loads that shorten shaft bearing life?	☐	☐
14. Are they free from power loss, regardless of adjustment?	☐	☐

To find out how your drives rate, see opposite page.

This "Driving" Test?

Score seven points for every "Yes" answer. How did your drives make out? If you scored from 84 to 98 points, your drives are excellent, you're using the best drives for your machines.

You're using chain drives.

If you scored from 64 to 83 points, your drives are probably in good shape, but you'd better check them over for possible improvements in chain application.

If you're using any other power transmission medium, you can't possibly score more than 63 points. Isn't that good evidence that your best bet for lower cost power transmission . . . greatest design flexibility . . . greatest efficiency . . . *is chain.*

And, for the best in chain, choose from the complete Chain Belt Company line of Rex® and Baldwin-Rex® Chains. More than 2000 sizes and types offer you the greatest range of selection . . . permit you to pick the exact size and type that will best fit your requirements.

For lower cost . . . for greatest efficiency . . . for top quality . . . for best overall results from your machines . . . specify *chain* . . . from the complete Chain Belt Company line.

For assistance in the selection and application of chain for your machines, for best overall results, see or call your Chain Belt Field Sales Engineer. He's ready, willing and able to help you.

In addition, a large list of helpful literature is available for the asking. Here is a partial list of titles which may be of interest to you:

Care and Maintenance of Chains—Rex Lumber Mill Chains—Rex TableTop Chains—Rex Chains for Cement and Rock Products Industries—Rex and Baldwin-Rex Conveyor Chains and Attachments—Baldwin-Rex "BA" Riveted Roller Chain—Baldwin-Rex Stock Roller Chains—Baldwin-Rex Flexible Couplings—Baldwin-Rex Tension Linkages—Baldwin-Rex Double-Pitch Roller Chains—Unusual Applications of Roller Chain. *Send for any or all of these booklets today.* Chain Belt Company, 4715 West Greenfield Ave., Milwaukee 1, Wis.

Rex

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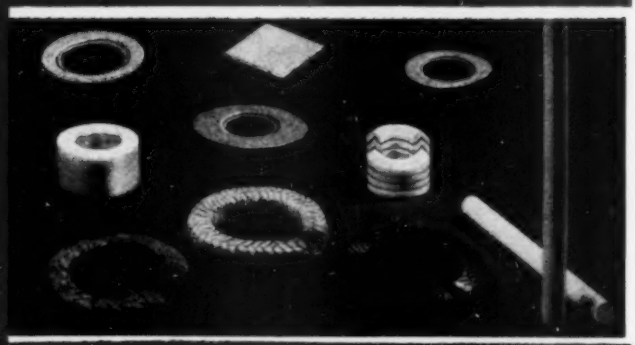
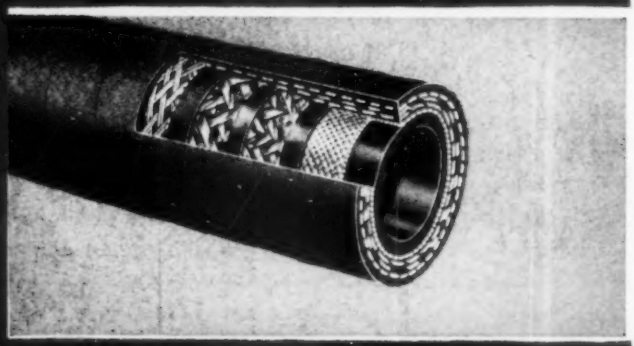
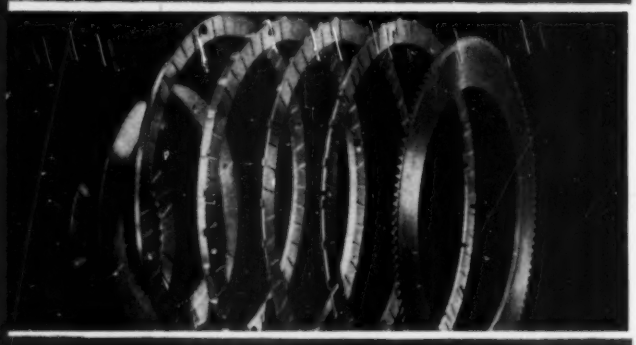
RM

Design people find Raybestos-Manhattan engineering service helpful on problems involving Asbestos, Rubber, Sintered Metal and Teflon* Products







Brake Blocks, Linings and Clutch Facings

Fan Belts and Radiator Hose

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

Conveyor Belts

Rubber Lined and Covered Equipment

SPECIALISTS IN ASBESTOS, RUBBER, SINTERED METAL

To better serve you PROMPTLY.. So that R/M sales, research and engineering can best coordinate to handle your problems . . . and so that we can serve you with least delay . . . please wire, phone or write the division listed under the product in which you are interested.

PACKINGS, GASKETS
ASBESTOS TEXTILES AND TEFLON PRODUCTS

Whatever your requirements for packings and gaskets, Raybestos-Manhattan is ready to meet your needs. If, for example, you have a problem involving chemicals, an R/M Packing made of Teflon may be your answer. For Teflon is unaffected by chemicals within the temperature range of −80°F. to 500°F. The R/M line, diversified and complete, includes packings for use against air, gas, water, steam, oil, solvents, foods and hydraulic fluids. R/M is also the manufacturer of an extensive line of asbestos textiles.

**Du Pont trade-mark for its tetrafluoroethylene resin*

PACKINGS, GASKETS, ASBESTOS TEXTILES AND TEFLON PRODUCTS

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Asbestos Textile Division
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

MECHANICAL RUBBER PRODUCTS

Super-Master BW Steam Hose is a typical example of R/M engineering in hose design. Here is a precisely balanced burstproof construction of asbestos, non-corrosive steel wire, and cotton braid for steam pressures up to 200 lbs. per square inch and temperatures to 388°F. The basic purpose of all hose is to control fluids or gases with safety, ease and long service. Whether your problem is one of pressure, temperature, corrosion or flexibility, R/M engineering and production facilities can make the hose to give you the kind of control you want.

Wherever you have a design problem that calls for hose—or transmission, conveyor belting, V-belts, or molded rubber products—let R/M engineers work with you.

MECHANICAL RUBBER PRODUCTS

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Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

FRICTION MATERIALS

If you have a friction material problem, Raybestos-Manhattan can give you unbiased advice and provide you with an element engineered to your specific needs. For R/M's seven great plants and laboratories are constantly working in both the metal and asbestos fields in order to satisfy the many different industries it serves. There are countless combinations of friction materials in R/M's complete line . . . including woven and molded asbestos, semimetallic materials, and sintered metal parts.

FRICTION MATERIALS

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RAYBESTOS-MANHATTAN, INC.

Rubber Covered Rolls | Sintered Metal Friction Elements | Asbestos Textiles | Teflon Tape, Packings, Sheets, Rods, Tubes

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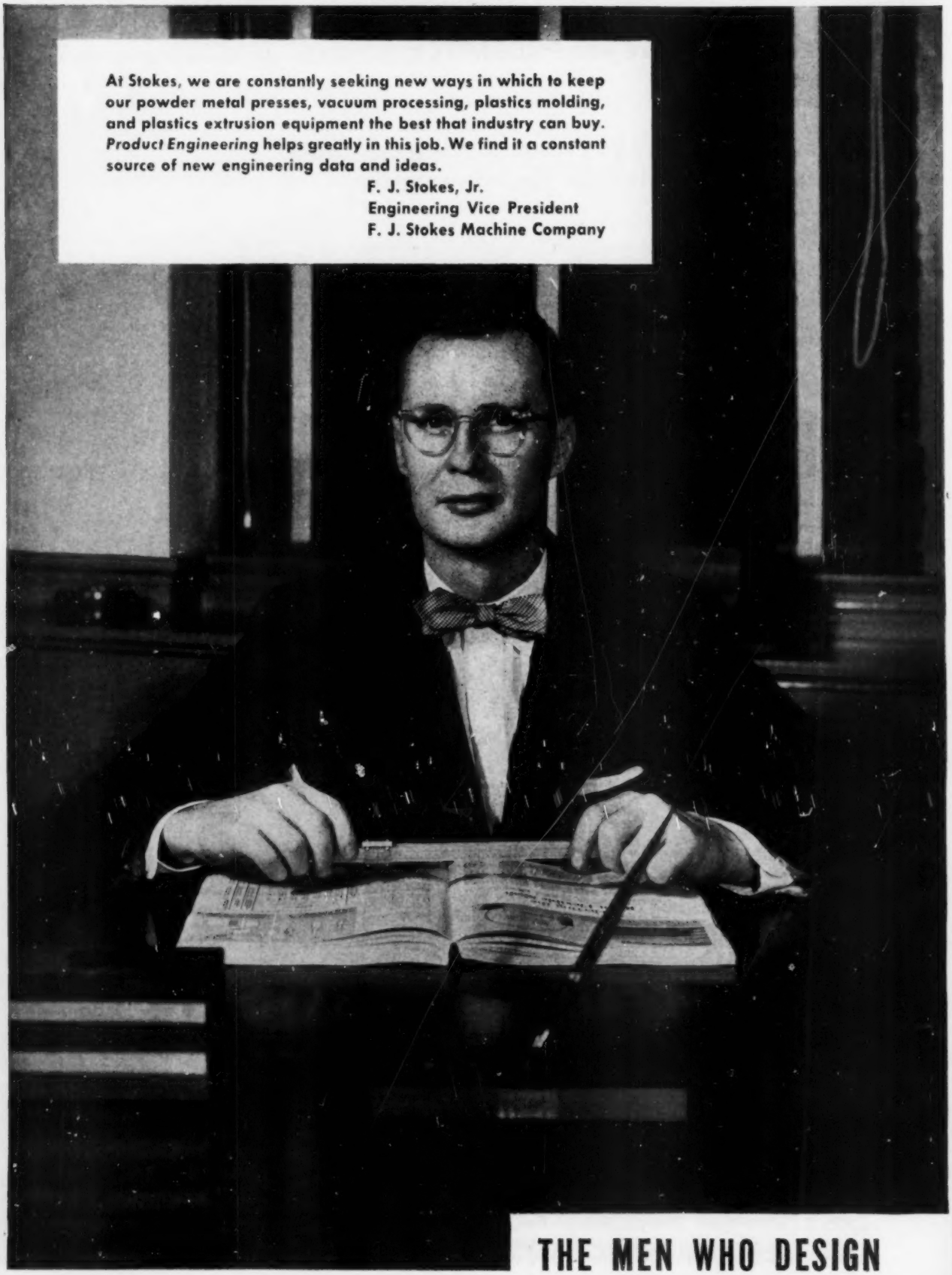
R/M



At Stokes, we are constantly seeking new ways in which to keep our powder metal presses, vacuum processing, plastics molding, and plastics extrusion equipment the best that industry can buy. *Product Engineering* helps greatly in this job. We find it a constant source of new engineering data and ideas.

F. J. Stokes, Jr.
Engineering Vice President
F. J. Stokes Machine Company

THE MEN WHO DESIGN

He leads product design at Stokes

HE READS PRODUCT ENGINEERING

You reach him best, with the facts about your parts, materials, components, or finishes, in this magazine that design-engineering leaders everywhere in industry prefer to all others edited for them.

Product-design engineers . . . the men who will select and specify over $26-billion of original equipment this year . . . read a design-engineering magazine for just one reason: they are looking for facts on new design techniques that can help them create better machinery, equipment, and appliances.

They find *more* useful facts and ideas in *Product Engineering* than in any other magazine. The result: over 22,000 design-engineers are now paid subscribers to this *only* ABC-audited, paid-circulation magazine in the design field, and they read it with a self-generated intentness they reserve for no other publication.

Advertising-wise, *Product Engineering's* editorial and circulation leadership builds exceptional advertising values. And year after year, advertisers to the giant Original Equipment Market invest more advertising pages and dollars in *Product Engineering* than in any other design publication.

Last year, this investment climbed to 4,210 pages, to make *Product Engineering* third among all monthly magazines, first among all monthlies in display pages, and first among design magazines by 1,330 pages.

If you haven't recently heard all the facts about *Product Engineering's* proved ability to sell *your* products, call or write our nearest office soon. You'll find these facts sound reasons for concentrating your advertising in this McGraw-Hill magazine of design-engineering.

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AMERICA'S NEW PRODUCTS READ PRODUCT ENGINEERING

Designer's

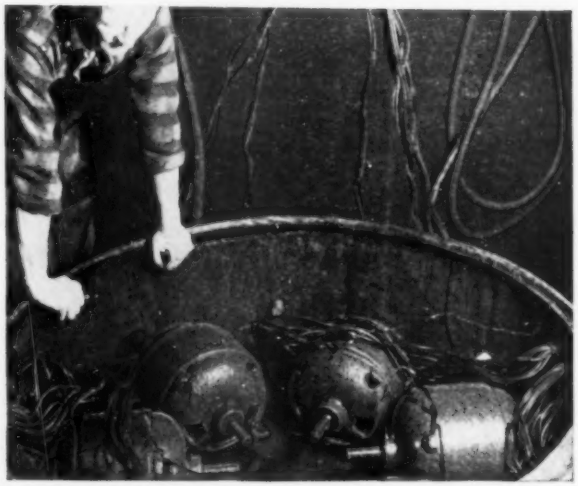
Build dependability into your product with a standard TRI-CLAD motor

REG. U.S. PAT. OFF.

Complete line simplifies selection, gives you extra motor protection

On more of the machines you make than you may realize, you can meet all your specifications with dependable, "off-the-shelf" General Electric Tri-Clad motors. The complete line covers a wide variety of hp ratings, voltages, speeds, mounting arrangements, and enclosures, including motors without feet, with face or flange end shields, and brake-motors.

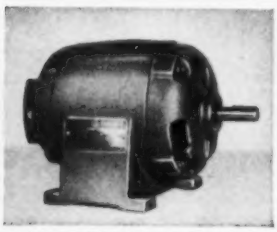
You get extra motor protection, too. Long-life bearing housing, designed to hold an ample grease supply, can be replenished when necessary while the motor is running. Sturdy, cast-iron construction protects motor against physical damage. Formex* wire windings resist moisture, oil and heat, and end windings treated with red Glyptal* lacquer withstand unfavorable ambient temperatures.



EXTRA PROTECTION against electrical breakdown is built in. Salt spray and other tests assure extra protection against operating wear and tear, and against physical damage.

Here's extra service that scores with machinery manufacturers. G-E sales and application engineers are always ready to help you solve product-motorization problems. In addition, extensive motor-service facilities are set up to serve your customers around the clock. A nationwide network of G-E Apparatus Service Shops and competent Small-Motor Service Stations is available to save you and your customers the cost of a motor-service organization. For more information on G-E Tri-Clad motors, see Bulletin GEA-3580.

*Reg. trade mark of General Electric Company



COMPACTNESS AND LIGHT WEIGHT of the G-E Type KCS single-phase capacitor motor suits it to many drives.

INDUSTRY'S MOST RELIABLE transfer mechanism has a totally enclosed switch that seals dirt from contacts.

Your product will offer more with a single-phase *TRI-CLAD* motor

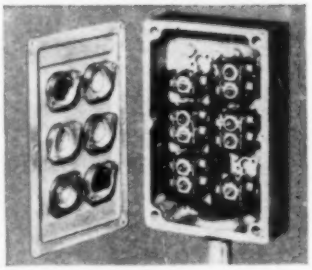
Here's one example of this outstanding motor line that's an asset on any machine — the Tri-Clad single-phase capacitor motor. Features include compactness and light weight, a sturdy, dependable transfer mechanism, long-lasting ball bearings, and easy-to-wire terminals. There are no brushes, commutator, short-circuiting devices, or brush-lifting mechanism needing attention.

GENERAL ELECTRIC

Digest

MOTOR & CONTROL HIGHLIGHTS

NEW PUSH-BUTTON ENCLOSURES PERMIT BACK-MOUNTING UNITS, SPEED WIRING



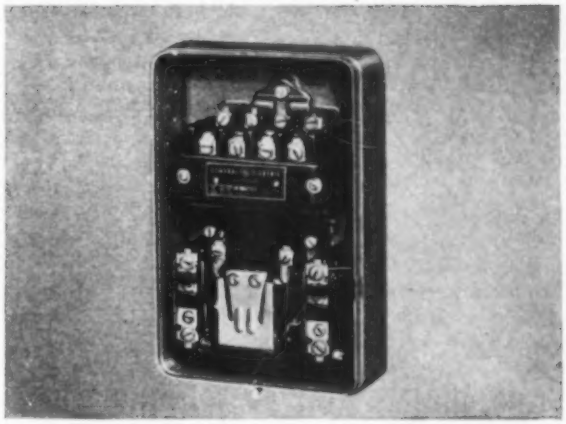
In General Electric's complete new oiltight push-button line, one of the many new features is an improved enclosure design (taking 1 to 9 units) that lets you back-mount units to simplify wiring. Contact blocks stay in place when cover is removed, permitting fast, easy connections directly to the blocks. Saves wire, too. Units can be front-mounted as well. Stations with any combination of a wide variety of units are available. See Bulletin GEA-5779.

POSITIVE ACTION WITHOUT BOUNCE: HEAVY-DUTY AC OR DC SOLENOIDS

You get longer life from G-E heavy-duty a-c or d-c solenoids because laminated frame and plunger of high-grade steel are pressure-riveted. Carefully designed coils minimize possibility of grounding. Complete line includes ratings from ¾-in. stroke at 0.65-lb. thrust to 3-in. at 97-lb. See Bulletin GEA-5163.

BUILT TO MEET JIC STANDARDS: EXTRA-PROTECTED MAGNETIC STARTERS

For use in dust- and oil-laden atmospheres, these G-E combination starters for JIC standards offer such protective features as oil-resistant door gasket, dual-voltage transformer, and exterior mounting bracket. Reversing and non-reversing types are available in sizes from 1 to 5 for 220-, 440-, and 550-volt a-c motors up to 100 hp. See Bulletin GEA-5715.



AC motor starters built for extra long life

Here are just a few of many features of General Electric motor starters that make them long-lasting. Fine silver contact tips plus extra-heavy contact construction spell long life. Arcs are snuffed at once by arc-resistant hood, prolonging contact life even more. Exclusive "Strongbox" magnet coil is locked in moisture-resistant plastic block to insure long coil life. These G-E starters are available in NEMA sizes 0, 1, 2, 3 for a-c motors up to 50 hp in general-purpose (illustrated), dust-tight, watertight, or explosion-proof enclosure. For more information, see Bulletin GEC-880.

General Electric Company, Section C 668-100
Schenectady 5, N. Y.

Please send me the following bulletins:

V for reference purposes X for immediate projects

- ☐ GEA-3580 Tri-Clad Motors
- ☐ GEA-5163 Heavy-Duty Solenoids
- ☐ GEA-5715 JIC Starters
- ☐ GEA-5779 Push-Button Units
- ☐ GEC-880 Magnetic Starters

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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COMPANY_____

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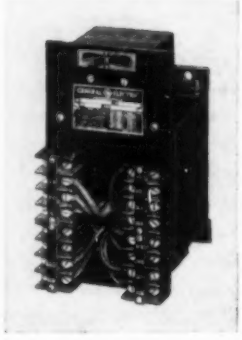
TURN PAGE FOR MORE G-E PRODUCT HIGHLIGHTS

MORE UNIFORMITY, FEWER REJECTS WITH SURFACE ROUGHNESS SCALES

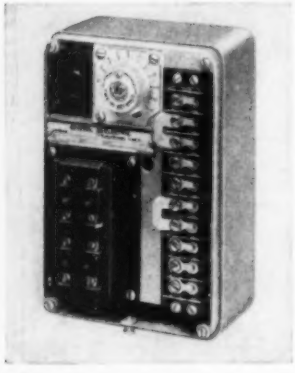
Design engineers can help eliminate the tendency to produce unnecessarily fine finishes, and reduce spoilage due to production of too-rough finishes, with G-E surface roughness scales. These scales provide a common standard of comparison for engineers, draftsmen, machinists and inspectors. Parts furnished by subcontractors can be quickly checked if you wish to verify specifications. The set, consisting of two 6-inch metal rules with leather case, has roughness representations from 4–4000 micro-inches in shaped, ground, and milled surfaces. See Bulletin GEC-774.

STANDARDIZED LINE OF MACHINE-TOOL TRANSFORMERS CUTS YOUR INVENTORIES

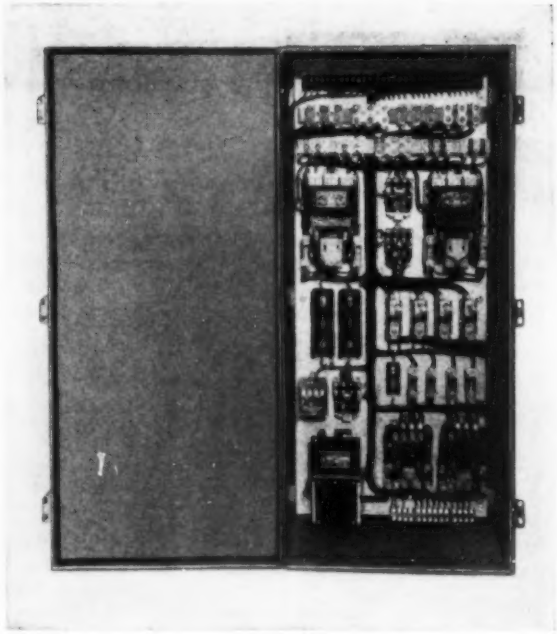
You'll reduce inventory and storage costs—save panel space and wiring time—with G.E.'s standardized machine-tool transformers. These cover practically all input-voltage conditions with only 23 ratings. Built-in overload protection includes a manual reset button which permits convenient and rapid reclosing of circuit. Ratings range from 0.075 to 3.0 kva for standard voltages, standard frequencies. See Bulletin GER-502.



EASILY-INSTALLED ELECTRONIC TIMER WITHSTANDS MILLIONS OF OPERATIONS



G-E electronic timer is quickly installed with simple screw-on mounting. All terminals are easily accessible, leaving plenty of room to wire. At full-rated load, timers are good for at least a million operations—up to ten million with less load. They operate from any standard 115-230-volt, 50/60 cycle, a-c power supply. See Bulletin GEA-5255.



Save 4 ways with custom-built G-E industry control panels

Machinery builders designing a new line can save time, effort and cost by letting General Electric design and supply complete, custom-built industry control panels. They can be made up in any size and type—from small, wall-mounted units to large line-ups of floor-mounted equipment, from simple single-motor control to complex, fully automatic control for multi-motored machines. All are carefully engineered by G-E specialists familiar with your customers' needs. High-quality G-E components are used.

Because G.E. assumes over-all responsibility for these panels, you save four ways:

You reduce the load on your own design and drafting staff, releasing them for other projects. All the engineering is done by G.E.

You save on inventory and storage costs of components, since these are all provided by G.E.

You cut assembly, wiring and installation costs. Panels are factory-wired and pre-assembled by G.E. in easily-installed units.

You avoid the need to set up a separate organization to service the control, or equip and train your agents to do it. G.E.'s extensive service facilities include 31 Apparatus Service Shops throughout the country, ready to serve round the clock.

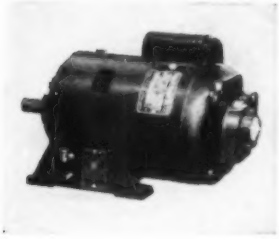
For more information on industry control panels, see your G-E Apparatus Sales representative.

GENERAL ELECTRIC

Designer's Digest

PRODUCT HIGHLIGHTS

SIMPLIFY YOUR SELECTION PROBLEMS WITH STANDARD FHP GEAR-MOTORS

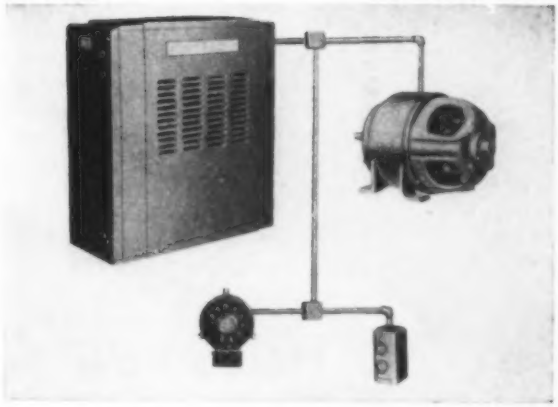


Choosing the right G-E standard fractional-horsepower gear-motor for any specific job is easy—with 61 models to choose from. These motors combine the efficiency and small size of normal-speed motors with strength and dependability of low-speed gears. Concentric-shaft type (top picture) is compact, easy to mount. Available in output speeds from 520 to 25 rpm, $\frac{1}{4}$ to $\frac{3}{4}$ hp. Right-angle shaft type (bottom picture) is permanently aligned. Available in speeds from 197 to 24 rpm $\frac{1}{6}$ to $\frac{3}{4}$ hp. See Bulletin GEA-5678.

SHADOW-FREE AND SPACE-SAVING: LONG-SCALE SWITCHBOARD INSTRUMENTS

Designers can make control boards easier to read by specifying General Electric long-scale, shadow-free switchboard instruments. Even in sharp, overhead lighting, shadow-proof covers permit these accurate, dependable instruments to be read quickly and accurately.

Anti-parallax scale and pointer permit reading from any reasonable distance or angle. Sustained accuracy and quick response are achieved through a lightweight armature. This complete line of instruments for measuring a-c and d-c electrical quantities is ideal for installations where space is limited. Twenty-five instruments can be mounted on a 24-inch square panel. Type AB-DB-18 ($4\frac{1}{2}$-in.) has a 250-degree, $7\frac{1}{2}$-in. scale; Type AB-DB-16 ($8\frac{3}{4}$-in.) has a 250-degree, 14.2-in. scale. See Bulletin GEC-218.



A G-E adjustable-speed drive will make machines more versatile

By powering the machines you build with a G-E adjustable-speed drive, you get "packaged" adjustable-speed control that meets all your specifications. Operating speeds and control functions can be closely matched to the work. Your machines become more versatile, more accurate, more productive.

For example, in G-E Speed Variators, m-g set and control are compactly packaged for easy installation. These packaged power units can be located away from driven machines to save floor space. Speed ranges run from 3:1 to 50:1, standard hp ratings from 1 to 200 hp. Other packaged drives are available as low as 1/40 hp. Check Bulletin GEA-5334 for the adjustable-speed drive to fill your needs most economically.

General Electric Company, Section C 668-101
Schenectady 5, N. Y.

Please send me the following bulletins:

√ for reference purposes X for immediate projects

- ☐ GEA-5255 Electronic Timer
- ☐ GEA-5334 Adjustable Speed
- ☐ GEA-5678 FHP Gear-Motors
- ☐ GEC-218 Switchboard Instruments
- ☐ GEC-774 Surface Roughness Scales
- ☐ GER-502 Machine-Tool Transformers

CONSULT YOUR McGRAW-HILL ELECTRICAL CATALOG FOR PRODUCT ENGINEERS! You'll find "everything electric" for machinery manufacturers in the General Electric section.

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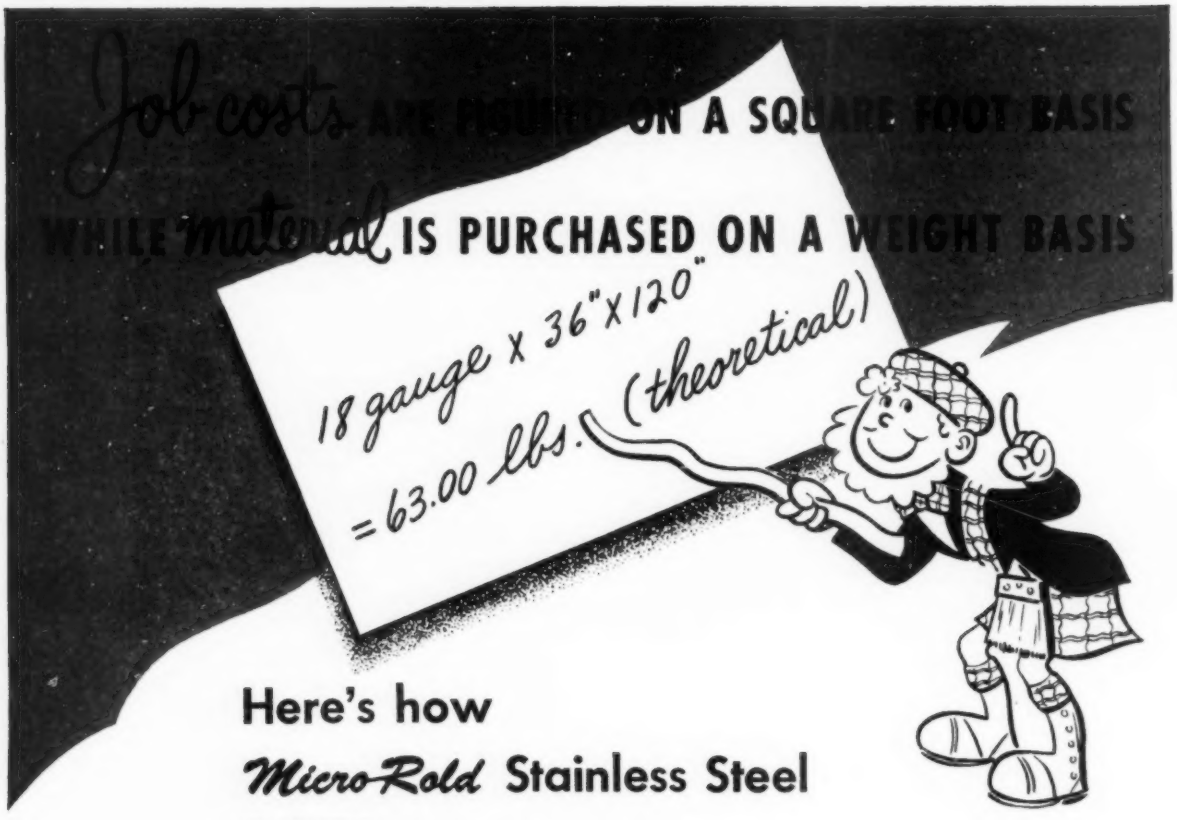
Job costs ARE FIGURED ON A SQUARE FOOT BASIS
WHILE material IS PURCHASED ON A WEIGHT BASIS
18 gauge x 36"x120"
=63.00 lbs. (theoretical)

Here's how *MicroRold* Stainless Steel SAVES you money

In the use of stainless steel, the selection of gauge number is usually determined by the minimum permissible thickness having sufficient strength to meet the requirements of the application. When you receive material on the heavy side of the gauge you are paying a premium for stainless surface area.

When sheets are ordered by gauge number, the permissible A. I. S. I. variation in thickness is plus or minus 10%. Thus, if you order 18 gauge, you may receive sheets .052" thick, when a thickness of .0475" would suit your purpose. Using a standard 18 gauge 36" x 120" sheet as an example, the theoretical weight is 63.00 pounds, but this weight could permissibly vary between 59.22 pounds and 65.52 pounds. Each .001" of thickness adds 1.26 pounds per sheet.

MicroRold sheets may be ordered by gauge number and you can specify they be rolled on the light side of the gauge range. This is true because the equipment is such that more accurate control of thickness is possible.

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Washington Steel

CORPORATION

WASHINGTON, PENNSYLVANIA

Perspectives ~ DESIGN AND DEVELOPMENT

LARGE PLASTICS MOLDINGS

After five years of experiment and limited production, the mushrooming plastics industry is ready to produce large moldings in unlimited quantities. Designers started hearing about these large parts in 1948 when a plastic television cabinet, weighing 35 lb, appeared on the market. In that year the appliance industry used 10,000 such cabinets. This year molders are turning them out at the rate of 160,000 per month.

Behind this expansion are two developments: 1) new big presses, and 2) improved resins. To make large parts, the plastic must flow rapidly to all portions of the die. Presses up to 2,000 tons and rapid-flow characteristics imparted to materials have solved the problem.

There is no clear cut definition of large moldings. Generally molders consider that a part qualifies if it fits one of these criteria: weighs over eight lb; the die has a land area in excess of 300 sq in.; or if the molder has to use a press in excess of 350 ton capacity.

Now molders and materials suppliers are looking for new fields. Their first problem: to disseminate design information and property data to those responsible for developing or redesigning products.

DESIGN SYMPOSIUM

To speed this process, some members of the Society of the Plastics Industry formed a Large Molding Committee. Their first concerted effort will be a symposium with the Society of Industrial Designers, scheduled for April 15 in New York City.

At this meeting Committee members will explain how to design for large moldings, describe facilities available, and enumerate the properties of plastics materials useful in this technique. After hearing this, the industrial designers will discuss past and future applications.

Market specialists feel that the furniture industry has the biggest potential, today, for such large parts. The Committee will aim its heaviest guns at this business. But manufacturers of industrial products are also considered prime prospects and will receive plenty of attention. At the symposium there will be a large attendance of product designers from industrial, appliance, and furniture manufacturers.

WHY LARGE MOLDINGS

Visitors will hear six reasons for changing from machined assemblies, die castings, or wooden assemblies to large plastics moldings:

1) Single step production is the most potent justification for using plastic moldings. Best example: the first plastic television cabinet required only six production operations, compared to 525 needed to finish the wooden cabinet it replaced.

2) Versatility in design. The Committee will stress these features--new heavy presses permit deep drawing; moldings won't warp; the technique permits molding-in inserts to reduce the number of assembly operations; and plastics retain good dimensional stability.

3) Appearance. Practically any finish or color is available. For special effects, there are metallizing, polishing or painting processes.

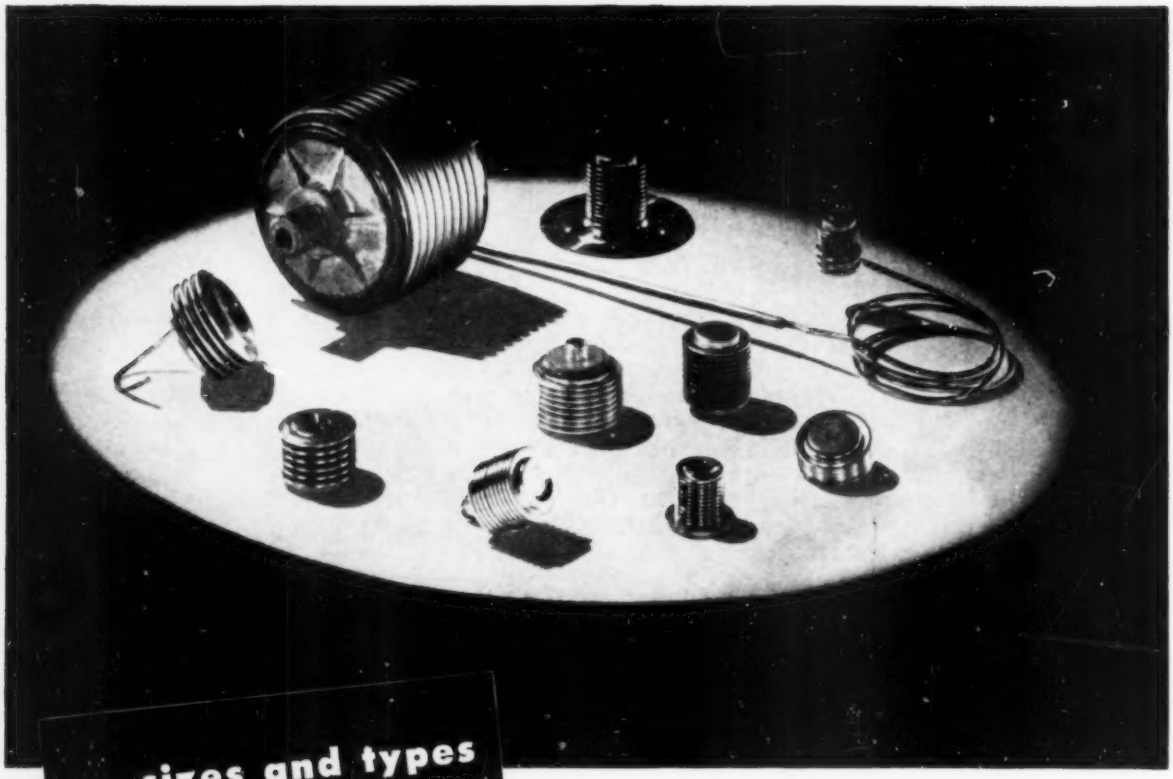
4) Corrosion resistance. The plastics used, do not corrode; they are resistant to most acids, greases, and solvents.

5) High strength-weight ratio.

6) Product appeal. Molders claim that the flowing lines of plastics parts will appeal to customers. Too, colors go all the way through so scratches do not mar surfaces seriously.

(Continued on page 133)

These are Flexon BRASS Bellows



. . . sizes and types to meet virtually every need

HERE'S YOUR GUIDE TO BELLOWS USE

The Flexon Bellows Design Guide offers useful application data and basic specifications on Flexon Brass and stainless steel bellows. Write for your copy, today or see Flexon Bellows specifications in Sweet's File for Product Designers.

Advanced manufacturing techniques employed in making FLEXON Brass Bellows make it possible for Flexonics Corporation to offer a wide variety of bellows and bellows assemblies as standard production items. For you, this means the greater overall economy that results from mass production and high standards of uniform adherence to your specifications.

For any product that requires a brass bellows, it will pay you to specify FLEXON Brass Bellows. For unusual applications, Flexonics bellows engineering specialists will be pleased to assist you. For quotations or recommendations, just send an outline of your requirements.

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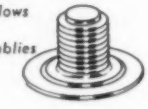
Metallic bellows and bellows assemblies

MATERIALS' PROPERTIES

To date, most successful results have been obtained with thermosetting plastics, particularly the formaldehyde materials - phenolics, ureas, and melamines. Below is a tabulation of the properties that make these materials useful in large moldings.

Property	Phenolic	Urea	Melamine
Specific Gravity	1.32-1.45	1.47-1.52	1.47-1.52
Tensile Strength--psi	6,500-8,500	6,000-13,000	7,000-13,000
Compressive Strength--psi	22,700-36,000	25,000-35,000	25,000-43,000
Flexural Strength--psi	8.500-12,000	10,000-16,000	10,000-16,000
Impact Strength--ft. lb/in. Notch	0.24-0.60	0.25-0.35	0.24-0.35
Dielectric Strength--v/mil	72-425	300-400	300-400
Dielectric Constant--at 60 cycles	5.0-9.0	7.0-9.5	7.9-9.5
Power Factor--at 60 cycles	0.01-0.30	0.035-0.10	0.03-0.10
Max. Operating Tem--deg F.	300-350	170	210
Shrinkage Factor--in. per in.	0.004-0.009	0.006-0.014	0.006-0.015

Phenolics are the oldest and most extensively used material but their use is tempered somewhat by a color limitation. Practically all phenolic moldings are either black, brown, mottled, or a shade of red. Urea and melamine parts can be any color but completely transparent; the latter have exceptionally good electrical properties.

To shape these materials, the industry has $10,000,000 invested in press equipment. This includes compressive presses from 500 to 2,000 ton capacity, and injection equipment up to 400 oz. Almost 75 percent of these facilities are pressing out television cabinets.

LIMITATIONS

The Committee wants potential users to know the limitations of large moldings as well as their advantages. These are the most important:

Size of run. Since parts require an expensive die, the cost of which may range from $10,000 up to $50,000, the production run must be large enough to justify the initial die cost, even though other savings may be substantial.

Size of part. The factor limiting size of part is the size of press available. Present capacities impose a weight limit of between 50 and 70 lb, and a die land area of 7 sq ft with a depth of 2 ft.

Specific applications. Plastic molded parts should never be used where they have to stand severe mechanical shock because the materials are somewhat brittle. And such parts should not be exposed to temperatures in excess of 350 F.

Choice of materials. In selecting a material, the designer should remember that ureas and melamines require two-three times the molding pressure needed by phenolics. This imposes a more drastic size limit on urea and melamine parts.

Now designers are using large plastic moldings for such applications as business machine housings, radio housings, washing machine agitators, compartmented furniture drawers.

For the future, the Committee predicts a big increase in plastic housings for all types of products, a switch to plastics for parts that can take advantage of the intricate detail reproducible by large molding, and more dependance on plastics where good electrical properties are required.

Materials suppliers indicate that 25 percent of thermosetting material produced is now going into large moldings. They anticipate a 50 percent increase in molding production by June of this year. Experts feel that present equipment can absorb this increase, and with the present supply situation, there is no shortage of raw materials in sight.

TINNERMAN

Speed Nut

SAVINGS STORIES

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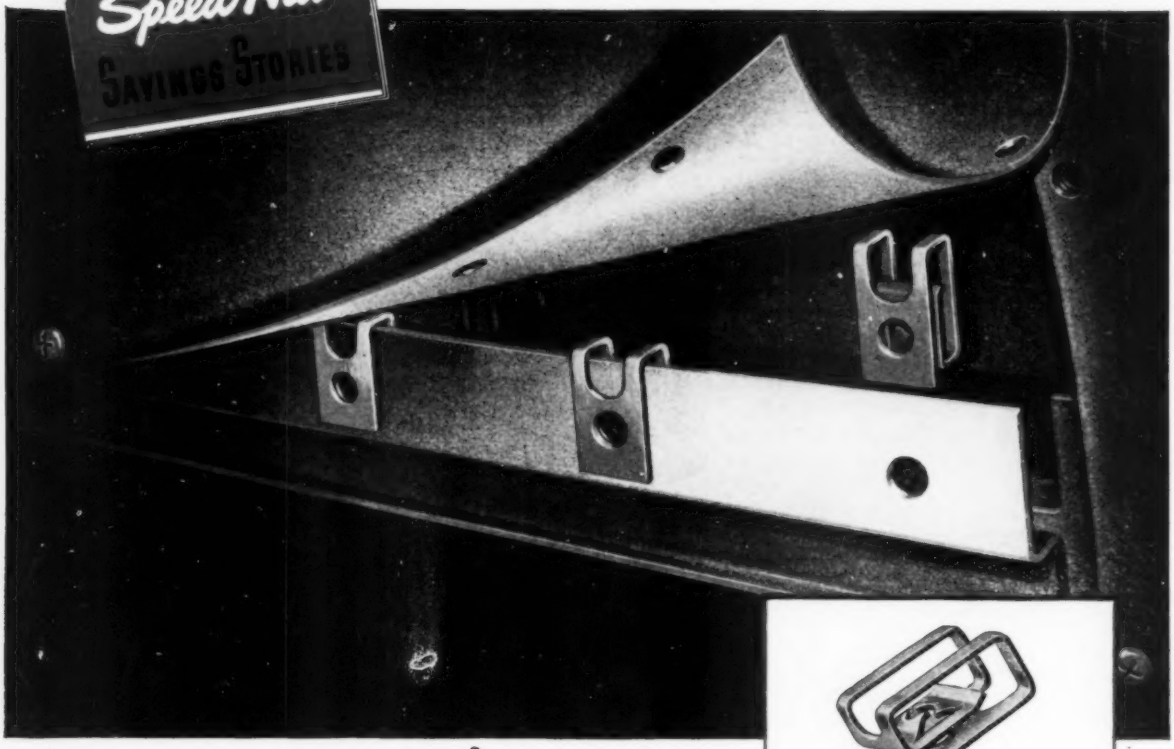
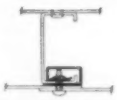


CONVAIR saves 448 man hours per plane...on one SPEED NUT fastening operation!

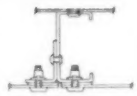
Tremendous savings like these by Consolidated Vultee Aircraft Corporation's San Diego Division may be hard to imagine, but...they can be made! Convair Engineering and Production experts are making this amazing economy on *one* SPEED NUT fastening operation... the installation of cargo liners in the new Convair 340 passenger transport! Also, the same operation yielded a sensational 80% reduction in production time, plus a 40% cut in materials and handling. Completing the story... the use of this U-Type SPEED NUT has eliminated an entire assembly section, releasing several trained aircraft workers to other production jobs!

Considered in terms of industry-wide aircraft production... savings and production boosts like these can mean millions of dollars. For similar solutions to fastening problems you may have, see the Tinnerman representative in your area!

U-TYPE SPEED NUTS



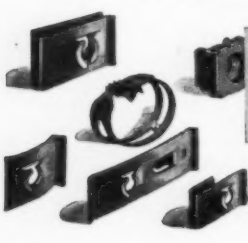
SPEED NUT WAY: A U-Type SPEED NUT and a No. 10 sheet metal screw are all it takes per hole application.



OLD WAY: Required: 2 each, Plate Nuts, Screws, Washers; 4 rivets; 1 angle trim; 1 doubler strip, per hole application.

Comparing the above methods it's easy to see how the 450 hole applications required per airplane amount to tremendous savings.

Send today for your copy of SPEED NUT "Savings Stories"; write: TINNERMAN PRODUCTS, INC., Dept. 12, Box 6688, Cleveland 1, Ohio. *In Canada:* Dominion Fasteners Ltd., Hamilton, Ontario. *In Great Britain:* Simmonds Aerocessories, Ltd., Treforest, Wales. *In France:* Aerocessoires Simmonds, S. A., 7 rue Henri Barbusse, Levallois (Seine).



TINNERMAN Speed Nuts®

MORE THAN 8000 SHAPES AND SIZES

A Graduate Can Measure A Bottle

MUCH PUBLICITY is now being given to computers of various types that can make tremendous calculations in an extremely short time. They can even store the figures and results. Problems that would normally require years for an expert mathematician to solve are worked by these machines in seconds. There is great danger that the publicity given to these machines will develop an exaggerated idea of the value and place of mathematics in engineering design.

One weakness found among some of the best engineers is that they insist on calculating everything. Their mistake is not that they do not know how. The error is that they do know how and try to do the impractical, whereas a simple test or experiment would give the perfect answer in far less time. It is the old story of determining the volume of a bottle. It might be measured and an answer obtained by calculus but the quickest and most accurate way is to fill the bottle with water and pour it into a graduate.

Smart engineers are those who are quick to see the limitations of mathematical calculations. They are the ones who are always seeking simple experimental methods that will give the answers, rather than resorting to calculus and other advanced mathematics.

Some men love to delve in mathematics. Some boast that their prowess in differentiating and integrating is of the highest order. They take great pride in arriving at their answers but pay little attention to the end result, be it a connecting rod or a gear. These are the men who fail to realize that in itself mathematical ability has little value.

Not until the mathematical results have been translated into a physical body, construction or machine, do they have any value. There is no profit in making calculations; there is profit in the creation of products and services.

It is no credit to an engineer that he arrived at the result by a devious mathematical route whereas he could have gotten a better answer more quickly by cut and try, tests, or experimental stress analysis. No company pays an engineer for his mathematical ability. He is paid for the value of the results he produces. If a graduate glass can produce an equally good result in less time, that is the thing to use.

George F. Nordenholt

● The "third degree" is but a superficial scanning compared to the trials a ball bearing must withstand in New Departure's Research Laboratory. Here, under conditions which pack years of normal use into a short time, engineers determine how to make the best ball bearings even better.

Production bearings and experimental designs, alike, take this "torture treatment." They are subjected to overspeeds and overloads, intense heat and cold, day and night operation for protracted periods.

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Three decades of this search and research have produced the sealed rear wheel-bearing for motor cars, the self-sealed bearing for farm implement use, the tiny, jewel-like bearing for delicate instruments . . . and many other types to fit a host of applications.

You can specify New Departures and *know* that they are right for the job. Keep your eye on the BALL to be sure of your BEARINGS!

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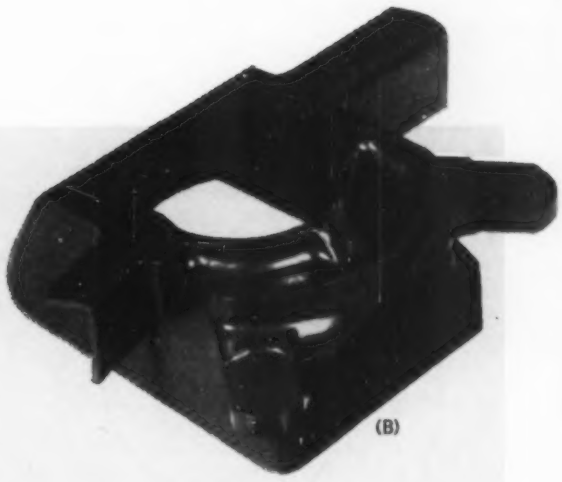
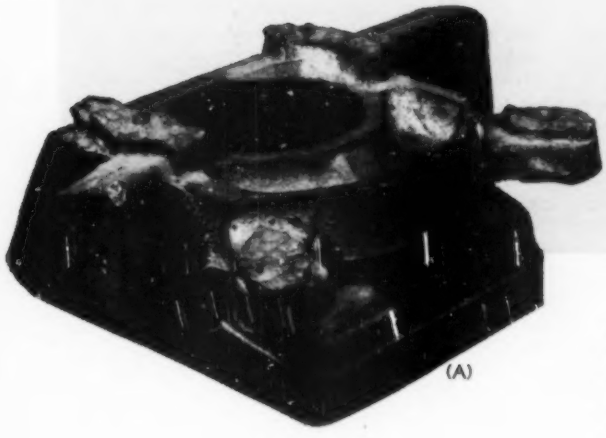
Investment Castings: They're Getting Bigger





The investment casting technique is no longer limited to small parts. Castings weighing 35 lb can be produced, thus extending the freedom with which the process can be specified.

Fig. 1—Sand cast landing gear fitting (A) weighed 18 lb, required approximately 150 hr to machine to finish dimensions. Precision investment casting (B) required only one hour to machine to finish dimensions. Weight 10¼ lb, widest dimension across angles 12 inches, height 3¼ inches.

J. R. BURNS
Supervisor, Manufacturing Research
Bell Aircraft Corporation

BIGGER PARTS—some measuring up to 16 inches in diameter and weighing up to 35 lb—currently are being produced in materials ranging from aluminum to high temperature alloys by the investment casting process. Compared to the 9 or 10 lb limits that have been generally accepted as the maximum weights that could be poured, these new limits represent a significant advancement in technique and control, and are of especial importance in the aircraft and guided missile industry where limited production of a prototype often precludes a heavy tooling investment.

However, there are several other factors that have added impetus to the use of the process in the aircraft industry.

1. The complexity required in new aircraft parts. Intricate or compound shapes that are difficult, impossible, or more costly to produce by other fabrication methods can readily be made by investment castings, thus permitting the design of parts in one piece to cut down weight and improve strength properties.

2. The use of hard-to-machine parts for high temperature and high stress service. Many high strength alloys, formerly considered too difficult to cast or which usually resulted in excessive scrap can be cast by advanced investment methods. Currently cast alloys include: stainless steels (AISI types 303, extra low carbon 304, 310, 317, 316, 410, 420, 430 and 440 C); carbon and low alloy steels such as AISI 1020, 1040, 4130, 4140, 4615, 6150

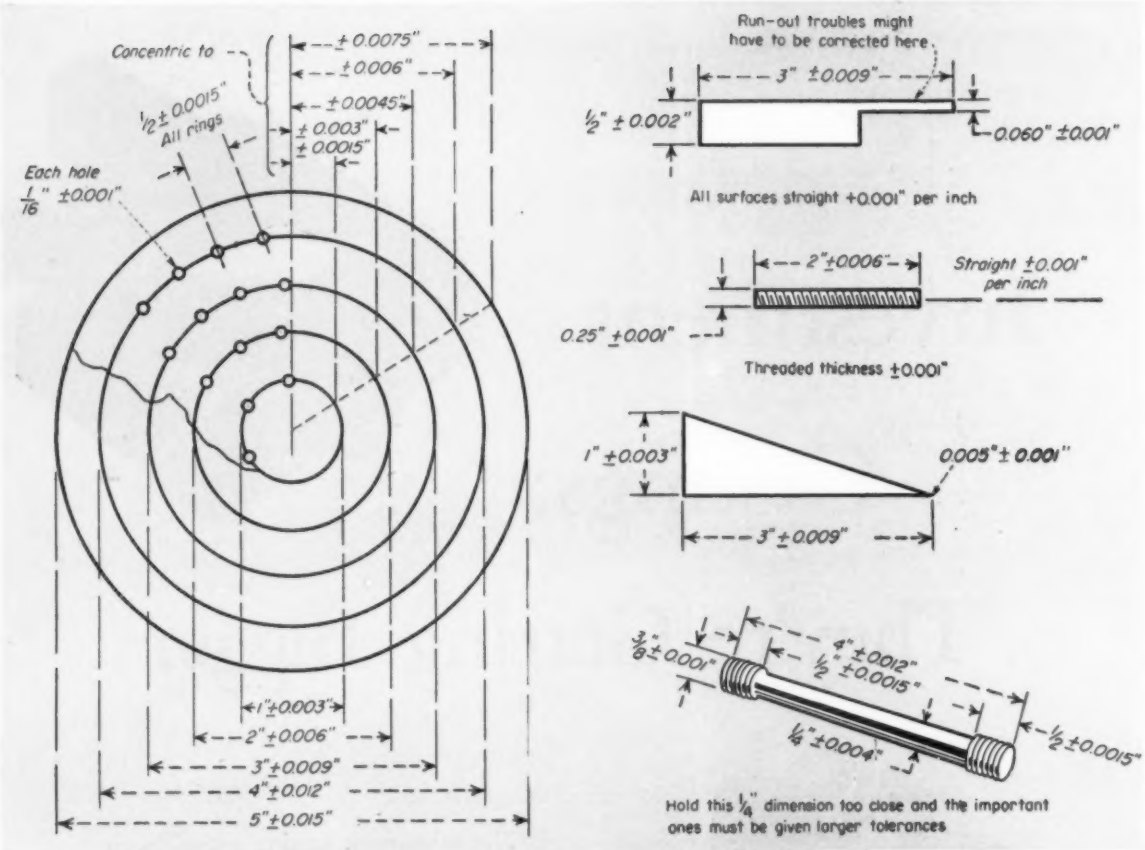


Fig. 2—Variations of tolerances with dimensions. As with other fabricating methods some dimensions are easier to hold than others. Tolerances should be specified only as close as the function of the part requires.

and comparable materials; cobalt-base high temperature alloys; nickel-base high temperature alloys; nickel-chrome-moly heat resisting alloys; copper and brass—in fact, any metals that are castable. In addition, a wide range of mechanical properties beyond those obtainable by conventional casting techniques is possible.

3. The need to reproduce fine detail, reduce cost, and minimize or eliminate machining. Usually tolerances can be held closer by investment casting than by most other casting techniques, and surface smoothness and detail is excellent.

It is generally agreed that the minimum tolerance acceptable for economical production on all dimensions except those across parting lines or gated surfaces is ±0.005 in. per in. on dimensions up to 3 in.; on dimensions of ⅜ in. or less ±0.003 in. can be held. Angle tolerances are usually ±½ degree. Small holes, ¼ in. in dia or less and about ½ in. deep can be held to ±0.003 in. with respect to diameter. Larger holes will require correspondingly larger tolerances. In Fig. 2 is demonstrated the effect of size on the tolerance that can be held.

If the designer demands high accuracy in all sections of a part the master pattern and the mold will be more costly to make. There will be high rejections of expendable patterns because of inaccuracies and of finished castings because of production errors.

If a production part is such that only a few critical dimensions require close tolerances, the die can frequently be designed so that these tolerances can be held. Tolerances on other dimensions should be only as close as the application requires and as liberal as possible.

Considerable savings can be realized if parts can be planned for completion with a minimum of machining or grinding on the dimensions of higher accuracy.

For these and other reasons, casting of large parts is not only applicable to aircraft but to many other industries as well. Large sections are being produced for the automotive industry, for example, to improve designs and to cut production costs.

Steps in the Process

Actually, the steps in casting large parts are not significantly different than those that long have been established. They include (1) forming the pattern in a mold; gating and assembling the pattern; investing the pattern by dipping into a clay slurry and flashing and drying; melting out the pattern and baking the investment mold; preheating the mold; pouring the melt; removing and cleaning the casting; inspection.

The big advance in size and density is obtained by temperature and pressure control. Melting and casting metals in the open air and relying on gravity feed to produce a nonporous casting will result in a vastly inferior product than if pressure is applied to the metal while it is solidifying; air, moisture and combustible materials are kept away from the metal during all stages of the process; and the temperature of the metal is controlled in each phase.

This can be best illustrated by fol-

lowing an actual part through production. The patterns for the turbine rotor, Fig. 3, are made of plastic. These patterns are gated and primary invested by dipping them into a slurry of silica flour mixed with a liquid agent that promotes the formation of a silica gel. This dipped pattern retains a wall of investment approximately 0.020 in. thick which conforms precisely to the most minute detail and eventually forms a glass-smooth inside surface of the mold. These refractories are permeable and allow air and gas to escape through the walls from the mold cavity. This tends to cut back the use of heavy risers and heads for pressure, and gives a denser casting than when made in sand.

The pattern is then placed on a steel plate (sprue downward) and a mold flask of heat resisting alloy is placed around the pattern and sealed to the plate with wax. Next, the secondary investment, which is a relatively coarse mixture of silica, calcined clay and liquid binder, is poured into the flask on a vibrating table to insure packing completely, thus bringing about complete support of the thin primary investment enveloping the expendable pattern. Following the solidification period of the secondary investment, the steel plate is removed, leaving only the pouring cup that is attached to the sprue exposed, while the pattern is embedded in a solid investment mold. The mold is then placed cup downwards on a grid and conveyed through a drying oven to completely dry and burn out the expendable pattern. The cavity of the mold which now has the detailed configuration of the pattern is ready for preheating up to temperatures as high as 1,850 F.; this pre-heat is determined by the casting characteristics of the metal to be poured. Once at temperature, the mold is rapidly transferred and clamped to the casting machine which contains sufficient metal to fill one mold. A seal is formed using an asbestos washer between the cup of the mold and the spout of the machine.

The casting machine is then inverted on trunnions, permitting the molten metal to enter the mold by gravity. Simultaneously, positive air pressure is introduced behind the metal through automatic valves on the trunnions. The operating cycle is very rapid—from 75 to 125 molds are poured per machine in a 24 hr day.

Types of Patterns

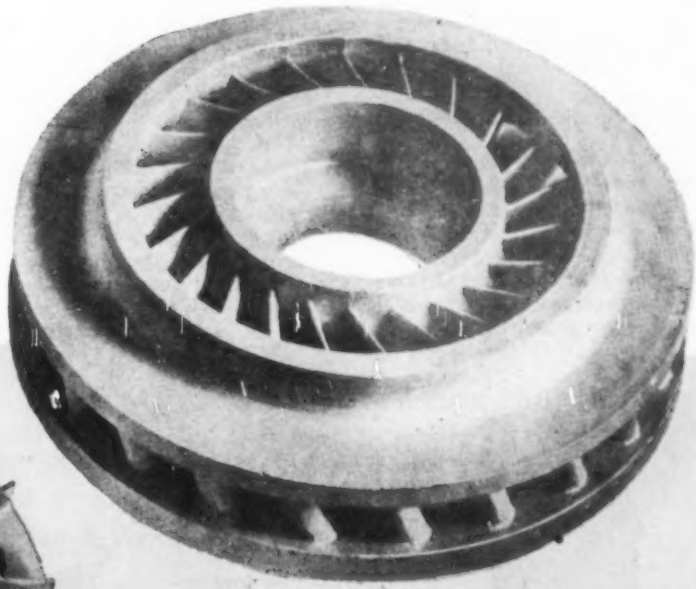
Pattern materials in common use include waxes, polystyrene, frozen mercury. Each is suited for specific uses and requires different handling.

Wax. The original dispensable material for patterns was wax. The waxes now used vary in melting point from 145 F to over 170 F.

The wax patterns are economical for small volume runs because of lower mold cost, but are primarily limited to small parts or to large parts that have no flimsy side walls or appendages. Soft metal molds can be used to cast the patterns, although for consistent results, steel molds are used. The waxes have the disadvantage of requiring immediate investment since their soft structure, poor rigidity and low softening and distortion point precludes excessive handling or storing for any length of time.

Plastic. Polystyrene is a much more substantial pattern material than wax because of its dimensional stability and rigidity. Plastic patterns can be handled without distorting or breaking, and can be stored for long periods without deterioration.

Polystyrene patterns require a more costly injection molding die, especially where intricate shapes are involved. However the higher cost will usually



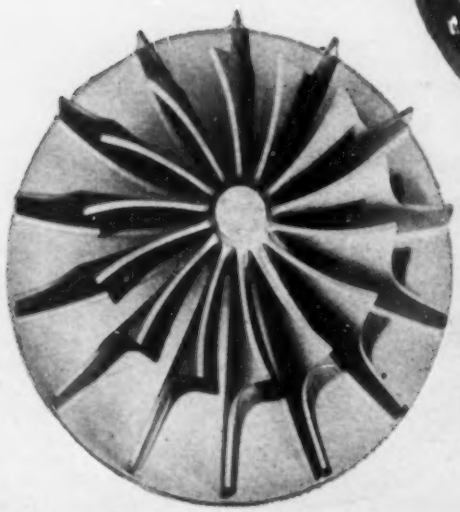


Fig. 3—Turbine rotor modified 316 steel. Forged billets were previously used to form this part. Buckets had to be milled out—an operation requiring about 80 hr. Produced by casting, cost is about $100.

Fig. 4—Investment cast turbine wheels for a 45 hp gas turbine utility engine are produced at 12 percent of their former cost. They are about 7½ in. in diameter, 3 in. high, and weigh only 8¼ lb, but by the previous method of production, they were machined from rough forgings weighing 30 to 40 pounds.

be offset in a run of 5,000 to 10,000 pieces, and production beyond this quantity will net a considerable savings. The plastic pattern is therefore advantageous when production quantities are high and design fairly stabilized. Other advantages are the accuracy and uniformity that can be obtained.

Frozen Mercury. The most recent pattern material used is mercury, which is poured into dies and frozen below —40 F prior to investing. This method is expensive because of the equipment required to operate at subnormal temperatures and because of the high equipment costs.

Such patterns are very smooth because of the high surface tension of mercury in the liquid form. Solidification characteristics minimize the tendency to cavitate and very heavy and thick sections are made without difficulty. The high fluidity of the mercury also permits production of patterns that have extensive areas of thin wall sections or blind projections.

Compound patterns of wax and plastic are being developed to allow for larger and more intricate investment castings. Finer sections, requiring high strength and smooth finish can be made of plastic and the thicker sections injected with wax.

Part and Pattern Design

Two factors of importance to the designer are the mechanical and physical properties that can be expected from the castings and the finish cast dimensions, relative to reduction or elimination of complicated tooling.

The investment casting process gives the designer greater latitude than other casting processes since nearly any alloy can be cast. Stronger alloys, or those more resistant to heat, abrasion, and corrosion can be selected. Often the parts can be made lighter in weight or smaller in size by the use of these durable alloys.

Threads, either internal or external of any sizes from those used on small instruments up to sizes of 1.00 in. or more can be produced by this process. Very seldom are their accuracies closer than No. 2 fit.

Contours of threads, of gear teeth and of similar shapes are easier to produce than it is to hold their accuracies. Any known thread contours can be produced, and as far as true and accurate contour of a thread is concerned, the process is satisfactorily accurate for the great majority of purposes.

Holes, recesses and chambers of larger diameters can be of any size that will leave adequate thickness of sections in the walls of the piece. Holes can be of any shape and can follow curved paths. Chamber entrances can be smaller than their main diameter. Small holes are dependent upon their lengths, location and their depths, and on whether or not they are to be open at both ends so that tiny rods of investment can be sufficiently supported as the castings are poured.

Extremely severe undercuts can be produced at a slightly higher cost of tooling and part piece.

Hollow parts can be produced to provide passages for liquids or gases or to reduce the weight of a part. Insofar as is practical they should have clear through passages. These passages do not have to go straight through: they can follow curved or angular paths, they can vary in width and diameter and in cross-sectional shapes.

Part Development

The high cost of tooling for large complex parts necessitates careful design and development prior to making the final pattern mold. The use of plastic for pattern material has helped to cut down the guesswork involved. To prove the feasibility of casting large, intricate parts the expendable pattern can be machined from a laminated plastic material. This technique has met with good success at Bell. Such complex parts as turbine rotors and fuel and oxidizer impellers have been cut from a plastic material, gated and invested.

After the first part is cast, a detailed inspection can be made to evaluate the results of the test. In many cases changes in design can be made to eliminate faults that may appear. A close check on dimensions will give a clear indication of the location and amount of shrinkage, warpage and other phenomena. This technique allows for greater flexibility of design prior to making the finished mold.

One word of caution: The production of such large parts is not a general procedure in the investment casting industry as yet. Only a few companies have advanced to this stage. However, the success gained so far is expected to stimulate activity in large casting production. Advancements in tooling and in investment refractory materials are expected to reduce costs and produce large castings of assured soundness and exceptionally smooth surface finish.

Fig. 5—With a wall thickness of only a little over ¼ in. this stainless steel investment cast fuel pump housing can handle 450 psi at 800 F. This part is 7 in. long and 3 in. in diameter.

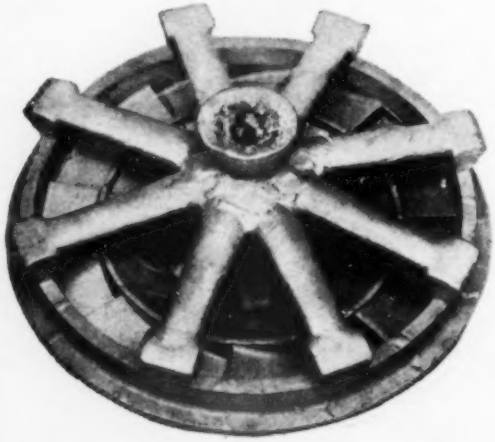


Fig. 6—(Right) Investment cast impeller ring with runners still in place. The milling operations on this part formerly required approximately 25 hrs. Now the entire assembly is cast for about $40.

Table I—Types and Characteristics of Storage Devices

Basic Physical Method	Specific Storage Device	Switching Time, sec	Term of Storage	Access Time, sec	Signal Retention	Power Requirements
Acoustical	Mercury delay line	5×10^{-5}	recirculate	2×10^{-4}	poor	high
	Alloy delay line	5×10^{-5}	recirculate	2×10^{-4}	poor	high
Dielectric	Straight capacity	variable	short	short	poor	medium
	Microcapacitor (cathode-ray tube)	2×10^{-5}	rewritten	2×10^{-4}	poor	medium
Electromechanical	Relays	10^{-2}	long	10^{-2}	good	high
	Engraved and embossed plastic (disk and tape)	10^{-2}	long	long	good	low
Electronic	Electron tube circuits (flip-flop)	2×10^{-5}	long	2×10^{-6}	good	medium
	Barrier type elements (germanium, transistors)	2×10^{-5}	long	2×10^{-6}	good	medium
	Cathode-ray (electrostatic, phosphorescent)	2×10^{-5}	rewritten (recirculate)	2×10^{-4}	poor	medium
Ferroelectric	Barium titanate crystals	10^{-5}	long	10^{-5}	good	high
Ferroresonant	LCR circuits	10^{-4}	long	10^{-4}	good	high
Magnetic	Drum	3×10^{-2}	long	10^{-4}	good	low
	Tape	3×10^{-2}	long	10^{-4}	good	low
	Wire	3×10^{-2}	long	10^{-4}	good	low
	Disk	3×10^{-2}	long	10^{-4}	good	low
	Core	3×10^{-2}	long	10^{-4}	good	low
Mechanical	Counters	slow	long	long	good	low
	Punched tapes	slow	long	long	good	low
	Graphic materials					
Optical	Visible phosphorescence	slow	rewritten	10^{-4}	poor	medium
	Infrared phosphorescence	slow	rewritten	10^{-4}	poor	medium
	Graphic materials					

Making Machines Remember

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While at present memory devices are mainly found in digital computers, advances in automatic control and manufacturing techniques have already resulted in the use of some of these devices in machine control elements.

SINCE MEMORY is the recognition and selection of recorded information on a time base, storage is a part of the memory process. Thus, a memory device must be able to store quantities of information so that they can be selected and used at a later time.

To perform these functions, a storage or memory device has certain basic requirements. There must be a writing means by which the information to be stored is introduced into the device; it must be possible to read or extract the information at the proper time; and it must be possible to erase the stored information. In addition the device must have a sufficient storage capacity over a desired time interval; and a means of tagging the information so that it can be easily selected when wanted.

In most applications, switching and selection (writing, reading, and erasing) are more important than storage capacity and retention time.

A common storage means is the recording of information by either writing or printing on sheets of paper. An example of this is the dictionary which on a relative basis has a high specific storage capacity:

Type of Storage	Specific Storage Capacity units per cm³
Human brain	6.7×10^{9}
Microfilm	3.4×10^{5}
Dictionary	3.5×10^{4}
Magnetic tape	1.8×10^{4}

Recent demands for improved memory devices have initiated the development of many interesting and useful types.

Storage Principles

Information is introduced into most memory devices in the form of a series of square wave voltage pulses. These pulses are of two levels, with the peak of the square wave representing the upper level and a zero voltage condition representing the lower level. The two levels of information might be represented in typical storage devices by a charged or uncharged capacitor, an energized or deenergized relay, or a magnetized or unmagnetized spot on a tape. Since two distinct conditions are available as the base of the information storage system, most memory devices use the binary base system.

The binary code is a means of counting by using two digits. These two digits can be represented by zero or one, or by a lamp being *off* or *on*. If the lamp is *off* no number or zero is indicated. If the lamp is *on* then a number or one is indicated. These two digits correspond to the two levels of pulse input into a storage device. This is shown by the sequence of numbers in Table II. The binary system uses the index base two, while the index base ten is used in the familar decimal system. Other bases are possible and are used.

With this notation, each piece of information represents two raised to a power in the *on* position, and zero in the *off* position. The power to which two is raised is indicated by the position of the *on* piece of information, with power being zero for the left hand position and increasing by one with each step to the right. (Power series ΣX^n where $X = 2$ and $n = 0, 1, 2, 3, \ldots$.) The number in the decimal system is found by taking the sum of the twos to the proper power. The advantage of this system can be seen in that four pieces of information give sixteen possible numbers (zero to fifteen) in the decimal system. The simplicity of operation, where large amounts of information must be stored, results in a minimum number of components. The arithmetic operations in computers are carried out in this binary notation and the results transformed into the decimal system at the output of the machine for recording.

In a magnetic tape storage system, a magnetized spot on the tape indicates an *on* position, while the absence of magnetization would be the *off* position. If the information stored on the tape was to be in the form of the number five, then the sequence of storage spots would be *on-off-on-off*, or for nine it would be *on-off-off-on*. Practical tapes have provision for more than four pieces of information, so that larger and more complicated numbers and words can be used.

Types of Memory Devices

As shown in Table I, there are nine major classifications of memory devices. These classifications are somewhat arbitrary since the various methods embrace and overlap all three of the basic sciences. For example, the ferroelectric type of storage device illustrates this combination of effects since it can be said to be electrical, mechanical, and chemical. The following discussion covers the storage devices in accordance with the physical storage property which most easily identifies one system from the others.

Acoustical Delay Lines

This type of storage device consists of a pair of crystal transducers with an acoustical material between them. In Fig. 1 is shown one of these delay lines with the accompanying schematic block diagram.

The information to be stored, in the form of voltage pulses, is fed into the input gate when the proper gating signal is supplied (gate is opened). These pulses are then combined with a standard time pulse in the pulse reshaper or clock gate, and the reshaped square wave input pulse is fed into the driver (power amplifier). The output of the driver causes the input quartz transducer to oscillate, producing a wave train down the column of the acoustic medium at the velocity of sound in this medium. The second quartz crystal at the end of the column converts the acoustic pulses back into electrical pulses. These converted electrical pulses are either read, if the output gate is open, or recirculated in the form of pulses identical with those originally fed in until such time as the information is required.

Thus, the input pulse wave is accompanied by a write or not write signal which tells it to go to the clock gate or to wait. If the signal is ad-

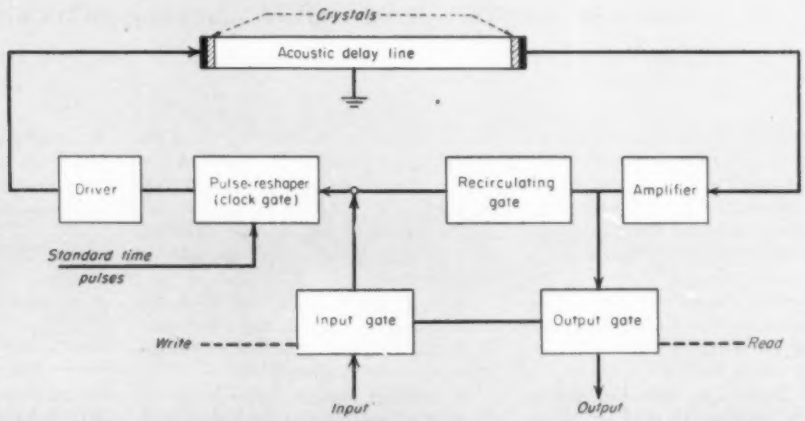


Fig. 1—Block diagram of typical acoustic delay line memory channel. Information pulses are fed into the input gate, converted into acoustical signals in the crystal transducers, and delayed in the mercury or alloy acoustic medium. Reconverted and amplified electrical signals are either fed out through output gate or recirculated for additional delay.

mitted through the input gate, it then gates the pulses from the timer and introduces a wave packet into the delay line. Another auxiliary signal (read or not read) determines whether the pulse wave is to be extracted or recirculated. The read signal must be timed so that it opens the output gate at the beginning of a wave train. No erasing is necessary since the circuit can store new information as soon as the information which was stored in the delay line passes through the output gate.

Several types of delay lines have been used, the original one using mercury as the acoustic medium. Others use metals and one type which has had some success has a magnesium alloy construction. These alloys can be used in a folded arrangement to facilitate space saving. All acoustical delay line applications are affected by temperature and some means of keeping the delay element within a small temperature range must be employed.

The delay achieved in each of these lines depends on the ratio of the velocity of the signal in the acoustic medium to that of the velocity in the rest of the circuit. The delay line using mercury as the acoustic medium has a delay of several hundred microseconds while the newer magnesium alloy delay lines have extended this to milliseconds. Delay line storage devices are used where short time storage is necessary while the arithmetic unit in the computer is in operation, or where the programming control unit directs information to be held while another operation is being performed.

The serial nature of information storage in the acoustical delay line gives rise to what is termed access time. Information must be stored or written in a definite sequence and must be read in the same sequence to be intelligible. This means that the reading must wait for the start of the stored cycle, giving a period of waiting for the cycle to be completed.

Electromechanical Devices

There are two principle types of electromechanical storage devices. One uses relay mechanisms for information storage and the other uses engraved or embossed plastic materials.

The relay circuit, Fig. 2 (A), will satisfy some of the simple requirements of storage and memory; however, most of these systems have been replaced by smaller more reliable and efficient units. The storage means of this device corresponds directly to the *on-off* operation mentioned previously. When the electromagnet coil is energized it attracts the armature, which moves from position *X* to position *Y*. The reading circuit is broken, and the condition for *off* operation or erasing is fulfilled. With the switch, *S*, open, circuit *B* is complete and the *on* condition is realized. Reading can be accomplished by a switching circuit running across a bank of such components to form a number, or in the simplest case by connecting an ohmmeter across t_1 and t_2 to indicate the *off* and *on* positions. Since this mechanism can only store one piece of information, it is a costly and bulky means of storage. Even small relays cannot compete with magnetic type storage systems in size, weight, speed of reading and writing, and reliability.

Engraved and embossed plastic materials can be used for storage, but the switching rate is low and information cannot be easily erased. An electromagnet operated recording head, Fig. 2 (B), embosses information on the plastic tape in the form of *on-off* pulses. The reading head is similar except that it converts the embossed information into electrical pulses. The presence of a pulse on the embossed line indicates an *on* unit and the absence of a pulse indicates an *off* condition.

Plastic materials are capable of storing many units of information; however, since they are difficult to erase they are best used for instructing the sequence of machine operations.

TABLE II

DECIMAL NO.	BINARY CODE	BASE 2
1	■□□□	2^0
2	□■□□	2^1
3	■■□□	2^0+2^1
4	□□■□	2^2
5	■□■□	2^0+2^2
6	□■■□	2^1+2^2
7	■■■□	$2^0+2^1+2^2$
8	□□□■	2^3
9	■□□■	2^0+2^3
10	□■□■	2^1+2^3
11	■■□■	$2^0+2^1+2^3$
12	□□■■	2^2+2^3
13	■□■■	$2^0+2^2+2^3$
14	□■■■	$2^1+2^2+2^3$
15	■■■■	$2^0+2^1+2^2+2^3$

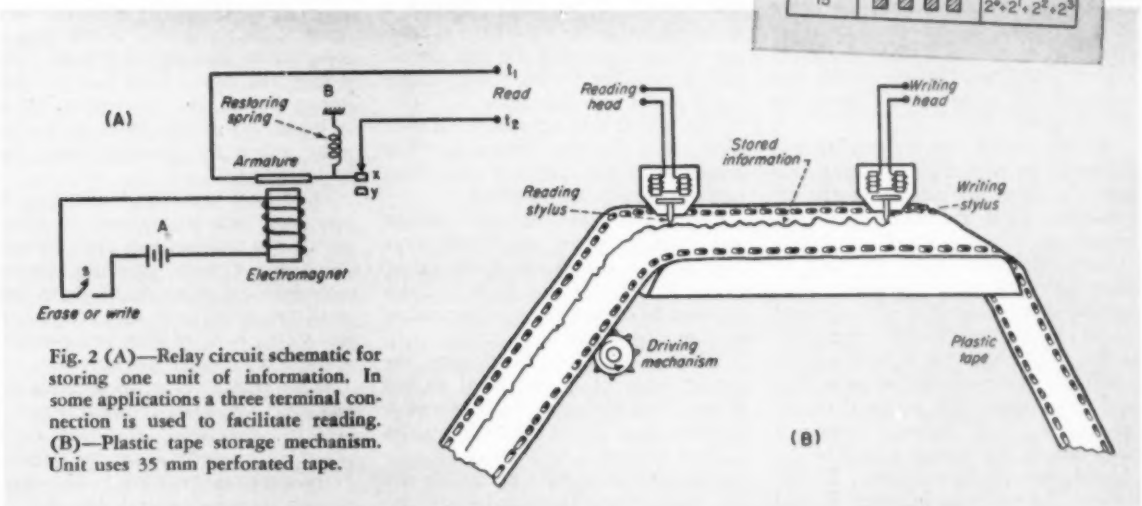


Fig. 2 (A)—Relay circuit schematic for storing one unit of information. In some applications a three terminal connection is used to facilitate reading. (B)—Plastic tape storage mechanism. Unit uses 35 mm perforated tape.

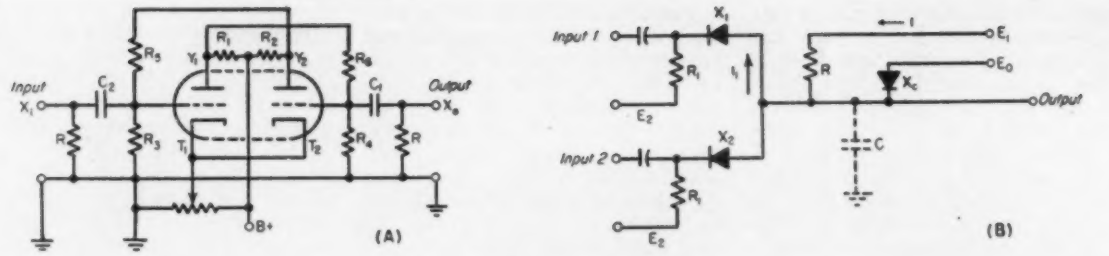


Fig. 3 (A)—Basic flip-flop storage or counter circuit. By connecting these devices in series, any number of digits can be stored or counted. (B)—Germanium diode gating circuit. Gates are used to control the input and output of stored information from a memory device.

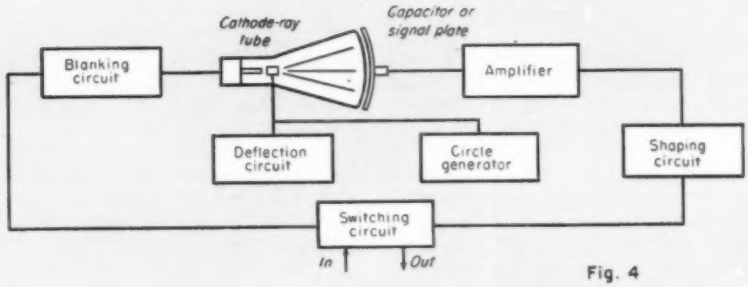


Fig. 4

Electronic Devices

Electronic memory devices include vacuum tubes, germanium diodes and transistors in flip-flop and gating circuits, and cathode-ray tubes for electrostatic or phosphorescent storage.

Electronic tube storage systems using flip-flop and similar circuits have the advantage of high speed writing, reading, and erasure. A typical fundamental flip-flop storage circuit, Fig. 3 (A), consists of a double electron tube amplifier connected so that there are two steady state conditions corresponding to the *on-off* positions in the binary notation. If one tube is conducting at full current, the other tube is biased to cut-off. The other condition is obtained when the tubes reverse functions, the one which was carrying full plate current becoming biased to cut-off.

In this circuit, the *on* condition is indicated by tube T_1 conducting and tube T_2 biased to cut-off; in the *off* condition, T_2 is conducting and T_1 is biased to cut-off. These conditions furnish the two digits required to store one unit of information. Assuming that the circuit is *off*, T_1 biased to cut-off, if a positive pulse is applied to the input, X_1, tube T_1 will start to conduct. The potential of point Y_1, and consequently the potential of the grid of T_2, will decrease, causing a reduction in the current passed by T_2. As the current flow through T_2 decreases, the potential of point Y_2 and the potential of the grid of T_1 increases. Thus, T_1 passes increasingly more current, and T_2 passes less and less until T_1 is carrying saturation current and T_2 is biased to cut-off. This represents the *on* condition.

To read the information, a positive pulse is applied to the output, point X_0. If the circuit is in the *on* condition, T_1 conducting, the positive pulse will cause T_2 to conduct and T_1 will become biased to cut-off. If the circuit is in the *off* condition, T_2 conducting, the positive reading pulse will have no effect. Since the reading pulse always sends T_1 to cut-off, erasing is accomplished at the same time as reading. Series connected flip-flop circuits can be used for storing more complicated pieces of information.

The principal disadvantages of electronic tube flip-flop devices are their unreliability and physical size when numerous units are involved.

Other types of electronic storage and gating devices use barrier type elements. A germanium diode gating circuit is shown in Fig. 3 (B). Gates are used to control the input or output of a storage device.

When used as an input gate, the output terminal is connected to the storage unit, the signal to be stored is fed into input 2, and the reading pulse applied to input 1. All voltages shown are referred to ground potential. All the square wave input pulses are assumed to be of equal duration, amplitude, and occur coincidentally. The supply voltages are adjusted so that:

$$E_1 > E_0 > E_2$$

and

$$I_1 > I$$

When there is no signal at either of the inputs, the clamping diode, X_C, and both coupling diodes, X_1 and X_2, are conducting. Thus, current flows in the direction indicated. When a reading pulse appears at input 1, X_1 is cut off. Since I_1 is greater than I, the clamping diode remains conducting. Under this condition, the application of an information pulse to input 2 will cause all the diodes to cut off, and the voltage at the output will rise exponentially with the time constant RC, where C is the output capacitance. This output voltage pulse is then fed into a delay line or other storage device. An information signal at input 2 will not cause an output pulse unless the reading signal has been applied.

Diodes are capable of operating at very high switching speeds of about one or two microseconds. In addition, they have a high reliability factor, with tests indicating that failures due to all causes are only about 5 percent for 2500 hrs of continuous operation if selected against a use criteria.

When transistors are more available, and have been more thoroughly tested in field applications, they will be a valuable component in storage circuits. Transistors can be used in the same manner as triodes and tetrodes in

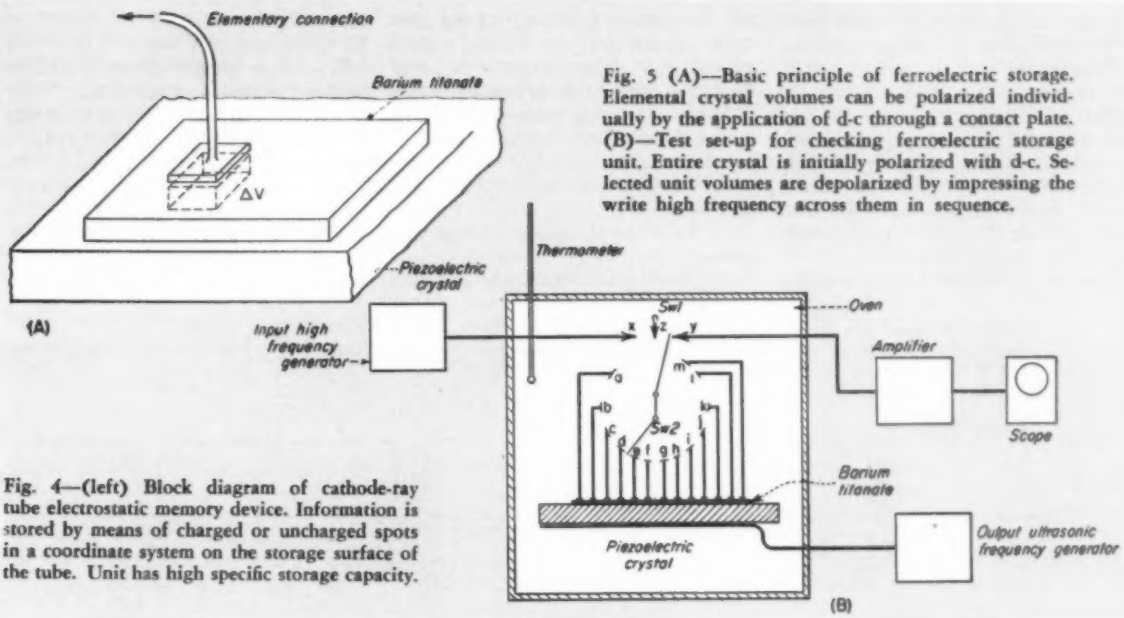


Fig. 5 (A)—Basic principle of ferroelectric storage. Elemental crystal volumes can be polarized individually by the application of d-c through a contact plate. (B)—Test set-up for checking ferroelectric storage unit. Entire crystal is initially polarized with d-c. Selected unit volumes are depolarized by impressing the write high frequency across them in sequence.

Fig. 4—(left) Block diagram of cathode-ray tube electrostatic memory device. Information is stored by means of charged or uncharged spots in a coordinate system on the storage surface of the tube. Unit has high specific storage capacity.

flip-flop circuits, with a sizeable reduction in the power required for filament excitation. These devices are small, reliable, light in weight, and fast in operation.

A cathode-ray tube can be used as an electrostatic storage device, Fig. 4, in which information in *on-off* form is stored in a capacitive coordinate arrangement on the surface of the tube. The surface is divided up into many small squares and a high-velocity cathode-ray gun adjusted so that it will scan these squares in a definite sequence. Each square can be thought of as a small capacitor which is charged or not charged depending on whether or not the electron beam was on or off when sweeping that particular square. Thus, if the grid has 32 divisions on each side, a total of 1,024 independent units of *on-off* information can be stored. The wave of pulse information which is to be stored determines which squares are charged.

In the diagram, the square shaped information pulses are fed into the switching or gating circuit. Then into the intensity modulating grid of the cathode-ray tube which controls the firing potential and electron stream of the high-velocity gun. The blanking circuit gives the equivalent of a pulsed operation by allowing the spots of information to be placed at specific points in the screen pattern. During writing, the capacitor or signal plate beyond the phosphorescent screen is maintained at a positive potential.

For reading, the capacitor plate is switched into the reading circuit and the high-velocity gun again scans the coordinate squares in the same order as that used in writing. When the electron stream from the gun strikes a charged dot, a negative signal appears on the capacitor plate. An uncharged dot registers a positive signal. The low level signals are amplified and fed into a shaping circuit which restores the square character to the pulse. These square pulses then appear at the output gate in the same order in which they were originally stored. The deflection circuit and circle generator are standard circuits used to scan the face of the cathode-ray tube and to produce small circular traces for each stored unit instead of a solid dot. This is used in more advanced systems.

This storage device operates at high speed and has a large storage capacity. The access time of the digital information stored in these tubes is about 10 microseconds compared to an access time of 168 microseconds for a mercury delay line storage unit.

The signals stored on the electrostatic tube can be monitored by using a conventional cathode-ray tube in parallel. By placing the conventional tube in a computer console, and feeding it with the same pulse signals, the operator has a continuous visual check on the stored information.

Dielectric or straight capacity storage has been used, where separate capacitors are used to store each unit of information. This system has many drawbacks, not the least of which are size and weight. Charge leakage and large time constants prevent high speed writing, reading, and erasing. However, condensers have been used where the number of units used was small and the switching rates were low.

Ferroelectric Storage

The ferroelectric type storage system uses the polarization effect of barium titanate crystals to store units of information. A crystal slab of this material, arranged between the electrodes of a direct current source, will become polarized. For storage purposes the crystal is divided into incremental volumes, ΔV, so that each small volume can be polarized separately, Fig. 5 (A). By this means a crystal slab can have many individual wire electrodes attached to the surface, each representing a unit to be stored. Erasure is accomplished by impressing a high frequency signal across the crystal surfaces. This depolarizes the small volumes by raising their temperature above the Curie point.

Since these crystals are capable of high speed writing, reading, and erasing, they exhibit the correct properties for an efficient storage unit. The energy required to polarize and de-

polarize barium titanate varies with temperature. Thus, if the polarization, depolarization cycle is carried out in the region of the Curie point the amount of energy necessary to read and write is much less than if the operation were carried out at a lower temperature. Since temperature is a critical factor, control must be provided so that the system will operate within the correct differential.

Another method of using these crystals for storage is to polarize the complete crystal after the erasing portion of the cycle. Then, units of information are stored by depolarizing the elemental volumes with a high frequency heat source. A summary of the steps in this process are:

1. Uniform polarization with a d-c potential.
2. Local depolarization by high frequency.
3. Reading as often as desired with ultrasonics.
4. Erasing as in Step 1.

An experimental device for checking this system is shown in Fig. 5 (B). The unit is housed in a constant temperature oven. Initially the crystal is uniformly polarized as in Step 1, by a means not shown. To store information, the contact arm of switch 2 is rotated from contact *a* to contact *m*. If an *on* unit of information is to be stored in the crystal volume connected

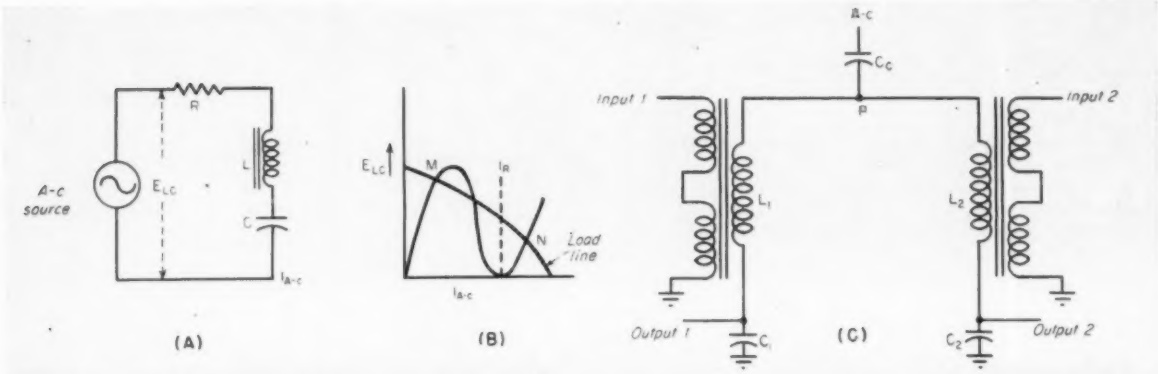


Fig. 6 (A)—Basic series *LCR* circuit. If this circuit is operated at the proper voltage, and *R* is low, there are two stable states as shown in (B). If an additional winding is placed on inductor *L*, the circuit can be made to jump from *M* to *N* by means of applying a positive pulse to this extra winding. By combining two of these circuits as in (C), a flip-flop storage unit is formed. Positive pulses alternately applied to inputs 1 and 2 cause the two *L-C* circuits to switch in and out of resonance.

Fig. 7 (A) Similar magnetic head to that detailed in (B) together with required accessories. The toroid coil is the reading coil used to amplify the induced voltage developed in the head.

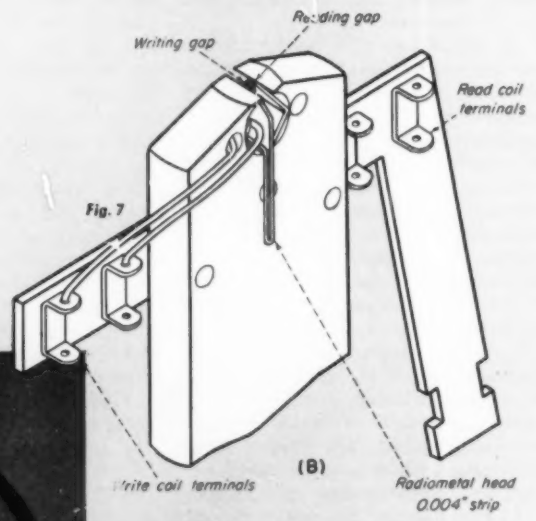


Fig. 7 (B)—Typical reading and writing magnetic head. Units similar to this can be used with any of the four types of magnetic spot storage devices.

Fig. 8 (A)—Magnetic storage drum used in British computers. Drum has a diameter of 11.5 in. and is 2 in. wide. Storage surface is 0.001 in. thick layer of nickel on periphery. Information is written by means of multiple magnetic heads, (B), placed 0.001 in. from the drum rim.

to contact *a*, the arm of switch 1 is placed in position *X* when the arm of switch 2 is in contact with *a*. Thus, the input high frequency generator is connected across volume *a*, depolarizing it. For crystal volumes which are to store *off* units of information, the arm of switch 1 is left in the neutral, *Z*, position. This is continued, contact by contact, until switch arm 2 reaches contact *m*.

To read the information which is stored in these small volumes, an ultrasonic frequency signal is impressed across the entire piezoelectric crystal and barium titanate by means of the output high frequency generator. Each elemental volume is then probed by means of switch 2 and the output is amplified for observation on the oscilloscope. Volumes which have not been depolarized (*off*) will pass most of the ultrasonic energy, while the ouput of the depolarized (*on*) volumes will be lower.

The advantage of ferroelectric storage is in the number of units which can be stored per unit volume. Its inherent speed of operation is about the same as the electrostatic tube.

Ferroresonant Storage

Flip-flop devices which operate on the ferroresonance principle can be used to store information in a manner similar to that of electronic flip-flops, but have the advantage of greater reliability.

The flip-flop action results from the bistability of a series circuit including a capacitor, iron-cored inductor, and resistance, Fig. 6 (A). The inductive reactance of the inductor, *L*, varies because of saturation over a portion of a cycle, while the capacitive reactance of the capacitor, *C*, is constant. This results in a voltage-current curve as shown in Fig. 6 (B), where I_R is the current at resonance. With the proper operating voltage and a low resistance, *R*, there are two stable values of I_{A-B}, one at *M* characterized by low current and high inductive resistance, and one at *N* where the current is high.

If a second winding is applied to the core of the inductor, *L*, the current in the circuit can be raised from point *M* to point *N* by the application of a d-c trigger pulse to the added winding. The trigger pulse can be of either polarity and successive pulses will not return the current to the lower value.

This principle can be used in a flip-flop circuit as shown in Fig. 6 (C). The reactance of C_c is chosen so that only one *L-C* combination can be in resonance at a time. If both should try to go into resonance, the voltage at *P* would fall so low that neither L_1C_1 *or* L_2C_2 could have sufficient voltage across them to maintain resonance. On the other hand, if L_1C_1 and L_2C_2 should both try to go out of resonance, the voltage at *P* would rise to such a value that one or the other would be forced to break down and go into resonance.

Thus if L_1C_1 is in resonance, a pulse applied to input 2 will cause the voltage at *P* to drop; this causes L_1C_1 to go out of resonance and L_2C_2 to go into resonance. A pulse at input 1 causes the reverse action to take place. If the condition when L_1C_1 is in resonance is considered to be the *on* position, and when L_2C_2 is in resonance to be the *off* position, this device can store one unit in the binary code. The information can be read by measuring the current flow in the outputs.

By connecting the two inputs together, the device will flip from one resonant condition to the other with each successive input pulse. This arrangement can be used for storage or as a binary counter.

Ferroresonant flip-flop units can be obtained in small plug-in elements about the size of a high vacuum diode. They are small and cheap. Switching time is fast, and storage is positive and permanent until the next writing or reading signal is received.

Magnetic Storage Devices

Of the five types of magnetic storage devices, tape, drum, disk, wire, and core, the first four are basically the same except for mechanical configuration. While some systems may better utilize one arrangement over the other as a matter of design considerations, the method of storage, reading, writing, and erasing is the same.

In each of these four arrangements information is written by means of small magnetic heads similar to that shown in Fig. 7. These heads are placed at a distance of about 0.001 in. from the magnetic storage surface.

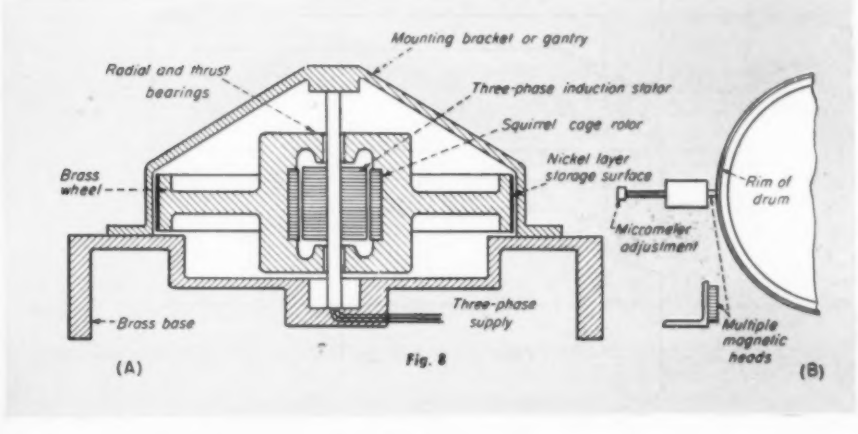


Fig. 8

When an information unit is to be stored, the head is magnetized and in turn induces a small magnetized area on the magnetic surface. When reading is required, the magnetized area induces a small magnetic pulse in the reading head. This pulse is amplified and is of the same character as the information which was stored. Erasing is done by inducing a current of opposite polarity over the storage area. This demagnetizes the magnetic surface and prepares it for future storage. In some devices the whole area is magnetized to one polarity before writing. Writing then consists of demagnetizing the incremental areas.

Using this system, *on-off* information of the binary form can be stored. In magnetic disks, drums, and tapes, several of these magnetic heads can be arranged side by side so that there are many rows of magnetized areas. With wire storage only one head is used.

Magnetic memories have a high specific storage capacity and give permanent storage. Thus, they are used where large quantities of information are to be stored for longer periods, while other more temporary storage means are used where the storage term is less than a few milliseconds. Magnetic tape has been used in a parallel way to punched and coded tape; to feed routine programming information

into the control unit of a computer.

A magnetic tape storage unit has been designed which has a capacity of 1,440,000 binary units; roughly corresponding to 36,000 words.

An interesting magnetic drum is shown in Fig. 8 (A). The drum is brass with a 0.001 in. layer of nickel for the storage surface. It is driven at a speed of 2,080 rpm as the rotor of a three-phase squirrel cage induction motor. Reading and writing are accomplished by two interleaved magnetic heads, Fig. 8 (B), having 32 units each. Each operation takes about 28.8 microseconds and the total binary capacity is 163,840 units.

The magnetic core, although listed under magnetic type storage devices, is more like the diode or ferroelectric crystal in its flip-flop characteristic and in the fact that its operating efficiency depends on temperature.

This device stores information by the use of a coordinate system, in which the coordinate lines are represented by wires with a magnetic core at each intersection. Each core has two stable magnetic states corresponding to the *on-off* binary notation.

The operation of this type of system depends on the hysteresis characteristics of the iron core material. The ideal hysteresis curve for this material is shown in Fig. 9 (A), where *A* and *D* are the two stable magnetized states. It is essential that the switching force, $2H_1$, be twice the magnetizing force, H_c. If a core is in the *D* magnetized state and one of its winding is energized positively, its condition will be represented by point H_1'. If the other winding is then energized positively, it will follow the curve counter-clockwise and flip to the *A* magnetized state after both lines are deenergized. Thus, current flow in one line has no affect on a cores stable position, but flow in both lines will cause it to flip to the other state. Current flowing in the opposite direction in both lines will cause the reverse action, or a switch from *A* to *D*. To date the best core material is Deltamax, Fig. 9 (B), but this is far from ideal.

A simple two dimensional storage and switching array is shown in Fig. 10 (A). This arrangement has two *X* coordinates, and two *Y* coordinates (four cores) so that four units of information can be stored. An additional output winding is required on each core for reading purposes.

In operation, assume that all four cores are in state *D*. If lines X_1 and Y_2 are energized, core x_1y_2 would be the only one receiving sufficient magnetizing force to switch its stable position to *A*. Cores x_2y_1, x_1y_1, and x_2y_2, with only one line energized, are left in state *D*. To read this unit of information, lines X_1 and Y_2 are energized in the opposite direction, changing the state of x_1y_2 back to *D*. In accomplishing this magnetic state transfer in the reading process, magnetic energy stored in the core is induced in the output winding of the core. This causes a pulse in the output line which is amplified for use. Thus the information is erased as it is read. If the reading energy was applied to a core that had not switched states there would be no output pulse. The presence or absence of this pulse corresponds to the *on-off* conditions.

At present, work is being done on a three dimensional array in which there are *X*, *Y* and *Z* axes. For this arrangement there are four windings on each core, three for writing and one for reading.

Temperature plays an important part in the operation of this device, Fig. 10 (B). Elevated temperatures improve switching time and give higher magnetized levels for a given core size. However, if the temperature is too high, the core material will go through an irreversible change.

At the present stage of development, these devices are subject to cross-talk and noise in the switching operations and have high operating power requirements and low specific storage capacity.

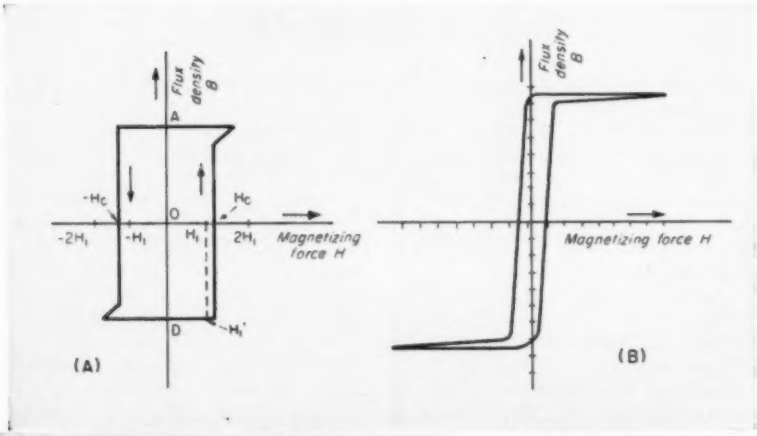


Fig. 9 (A)—Ideal hysteresis loop for core material used in magnetic core storage devices. (B)—Hysteresis loop for Deltamax which is manufactured by the Allegheny Ludlum Steel Corp.

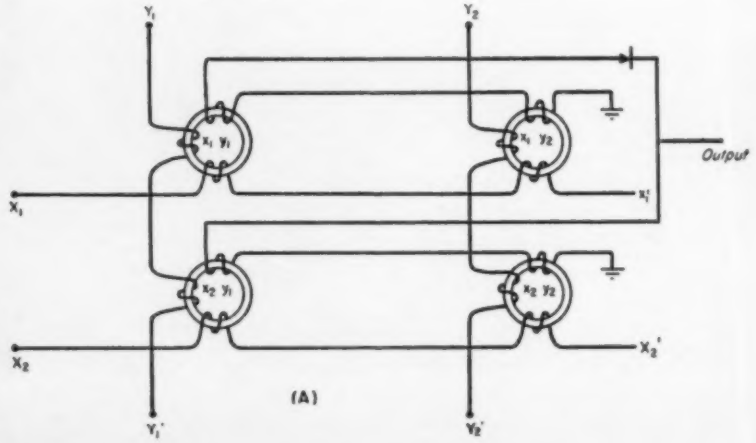


Fig. 10 (A)—Two dimensional magnetic core storage and switching array. This arrangement will store four units of *on-off* information. (B)—Variation of switching time of typical magnetic core unit with temperature.

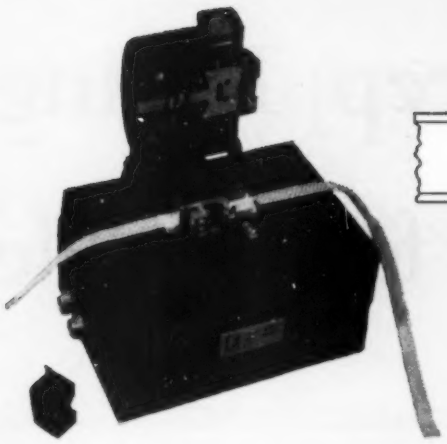


Fig. 11—Punched tape reader with a capacity of 300 words per minute. It can read a five or seven hole teleprinter tape, and takes 6 milliseconds to evaluate a frame. Pick-up is by phototube.

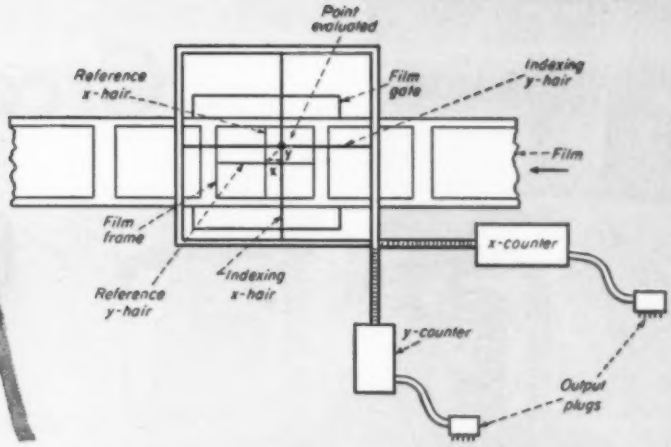


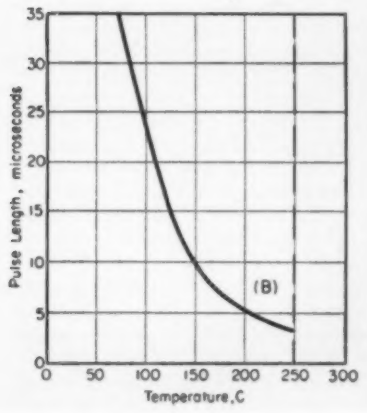
Fig. 12—Film evaluator using mechanical counters to store coordinate information. The film gate holds the frame of film which is being evaluated. The indexing hairs are either zeroed before the film is fed in or checked against the reference on the film.

Mechanical Devices

Mechanical counters, and punched and written tapes have rather limited use as storage devices. The two types of tapes are only used for routine or subroutine problems in programming, Fig. 11. However, even in this application magnetic means, such as tape, is much more conservative in space, weight, and associated equipment.

Mechanical counters can be used for storage purposes if they have suitable electrical output. One application uses a counter as the storage means for a film coordinate evaluator. In this device, Fig. 12, it is desired to determine the X and Y coordinates of points on a frame of film. The film is fed into the evaluator a frame at a time. The points that must be checked are then placed in coincidence with the indexing cross hairs by motor or manual drive. The counters rotate in the proper direction to indicate, in a positive or negative sense, the coordinates of any point under evaluation. The values stored in the counters are transferred to a control point where they are coded or programmed in the proper sequence for recording on an electric typewriter or punch card.

The counters have coded dials, usually set up in the binary system, with a capacity of six to eight decimal digits. They are capable of operating at rates up to one million counts per minute. When a number has been set on the counter, electrical feelers are disposed on the dial rims and the digits read out in sequence.



Optical Storage

Optical storage means have received little attention since most of these devices have been designed to solve specific problems.

A radar control application is a typical example. This device uses optical storage to change the scanning rate of a radio frequency scanner (bandwidth compressor). Signals received in one band width are optically recorded on the surface of a phosphorescent treated drum at a rate of 60 cps. They are then scanned or read by another similar optical system at a reduced rate of approximately 6 cps. The signals are recorded at this lower frequency. The drum acts as a storage link, remembering the information obtained at a high rate until it can be recorded at a practical lower rate.

Although the speed of writing and reading is slower than magnetic tape or drum, this system may solve certain storage problems.

Another means of optical storage is based on the properties of certain phosphors which are sensitive to infrared radiation if they have previously been irradiated with ultraviolet or short wavelength visible light. The irradiation throws the atoms of the phosphorescent material into a metastable state (a state in which an electron occupies a higher energy level than required by equilibrium conditions), while the application of infrared radiation restores the stable state.

By this process, information can be written by ultraviolet radiation and read by infrared radiation.

Although these optical methods are interesting and in many cases useful, they are too slow for high speed operation and the required equipment is too cumbersome for most applications.

For additional information on these devices see selected bibliography on page 274 of this issue.

Creep Testing for Simple

Fig. 1—Two compression creep machines of the type described, with their associated electrical control panels. Compared with tensile creep machines, they are compact and require little laboratory space.

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IN THE DEVELOPMENT of new creep resistant materials a survey of the creep properties of a group of alloy compositions often aids in selecting the most promising one for a more detailed study. To obtain this data, however, it has generally been necessary to subject a test specimen to a known stress at a constant temperature for long periods of time. These test periods vary in length, depending upon the end use of the product. Since the permitted creep strain is often only one or two percent for a long life mechanism, it is often required to measure strain rates which are as small as 10^{-6} or 10^{-7} in. per hour.

Obviously, the accurate measurement of such slow strain rates requires sensitive strain measuring equipment, accurate control of the testing temperature, and the use of relatively large specimens. The use of highly sensitive strain measuring equipment for such a survey is often undesirable, since specimen failure under test can sometimes cause damage to expensive extensometers. Specimens with a gage length of 3 in. are common for such tests, and specimens with a gage length as large as 12 in. have been used.

Typical of the difficulties encountered in applying conventional creep test techniques to experimental alloys was a case where it was required to survey the creep properties of alloys in a large number of chromium alloy systems. The chromium rich alloys in these systems had very high melting points (up to 3,630 F), were difficult to cast in a large ingot sound enough for creep testing, and were so brittle that they had to be ground to the required shape. The provision of large and sound castings and the grinding of conventional creep test specimens represented an experimental difficulty. In this problem, therefore, as in others which have been encountered, such as the examination of the creep properties of very small specimens cut from turbine blades, the need was felt for some test procedure which would give some assessment of the creep properties, not necessarily with high accuracy, but which would utilize a relatively small specimen. A consideration of the problems involved led to the conclusion that a study of creep in compression would minimize a number of the experimental difficulties.

In tension tests it is necessary or desirable to screw-thread the ends of the creep specimen, which is difficult with hard or brittle materials. It is also necessary to screw-thread the grips by means of which the stress is applied. In testing at temperatures of 1,650 to 1,850 F or above, this leads to considerable difficulty, since the available alloys for the manufacture of grips have such a low degree of resistance to creep at these temperatures that excessive creep occurs in the threads, Fig. 2. This may lead to failure in the grips, or to binding of the specimen at the threads, making it difficult or impossible to remove it from the grips after the test. In com-

in Compression Creep Assessment

pression, both of these difficulties can be avoided. By using the specimen as a strut, the stress can be applied by flat ended compression members bearing on a flat ended specimen. Since the compression members are of simple shape, they can be made of a highly creep resistant refractory substance which does not creep significantly at the test temperature.

Design of Apparatus

The design of a simple but effective compression creep testing machine is illustrated by Fig. 3 which shows the principle of the method, and by Fig. 4 which shows a section through the machine. The machine is of the lever loading type with a 10:1 lever ratio.

The creep of the specimen is determined by measuring the deflection of the loading beam with a dial gage graduated in 0.0001 inch. The ratio of the beam deflection, at the point at which the deflection is measured, to the change in length of the specimen, is 8:1. The apparatus is mounted upon a 1 in thick-steel plate (*R*). The load turns about a knife edge (*S*), resting on an adjusting lever (*U*) and pivoted on a cross beam (*T*) mounted on two one-inch diameter pillars screwed into the base plate. These pillars are made of Invar to minimize the effect of changes in ambient temperature.

The beam may be adjusted for relevelling by the auxiliary lever, seen to the left in Fig. 2. The specimen (*M*) is compressed between two push rods (IP) of recrystallized alumina. The bottom rod (*P*) is ground cylindrical and sits in a circular anvil (*Q*) of heat resistant alloy. A hollow cylinder of stabilized steatite (*N*) is mounted concentric with the bottom push rod anvil and guides the top and bottom push rods.

For work at temperatures up to 1,450 F to 1,650 F, the Steatite guide may carry a guide made of heat resistant alloy (L), but at higher temperatures it is advisable to use Steatite only, as oxidation of a metal guide leads sometimes in long term tests to jamming of the push rods in the guide, the clearance being very small. The top push rod (I) is ground spherical at the top to assist axial alignment of the stress. The specimen and push rod assembly is enclosed by a fused silica furnace tube (*H*) wound with resistance wire.

The temperature of the specimen is measured by a thermocouple which

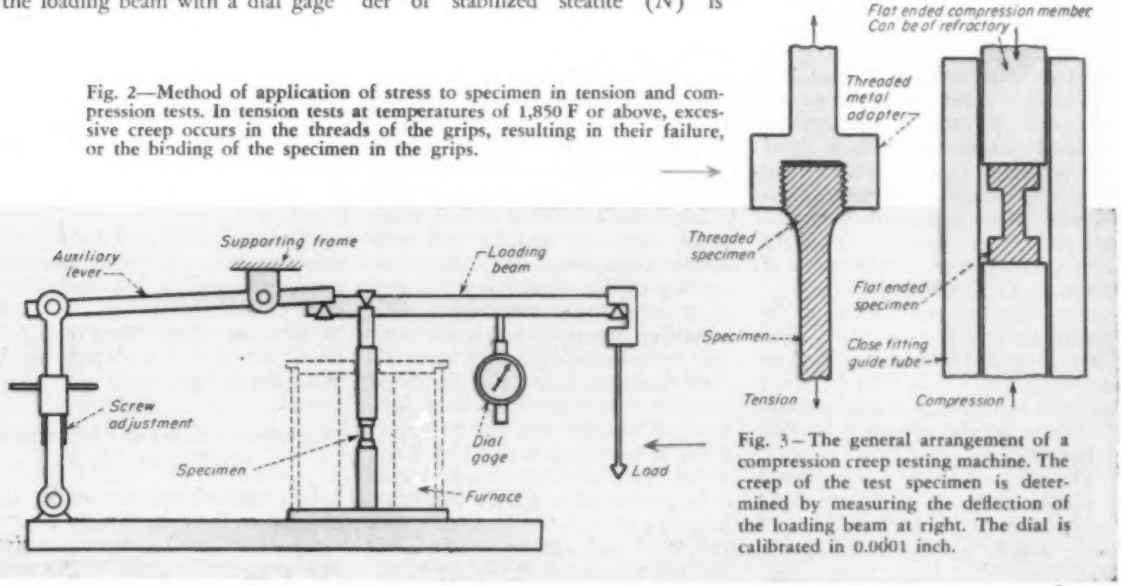


Fig. 2—Method of application of stress to specimen in tension and compression tests. In tension tests at temperatures of 1,850 F or above, excessive creep occurs in the threads of the grips, resulting in their failure, or the binding of the specimen in the grips.

Fig. 3—The general arrangement of a compression creep testing machine. The creep of the test specimen is determined by measuring the deflection of the loading beam at right. The dial is calibrated in 0.0001 inch.

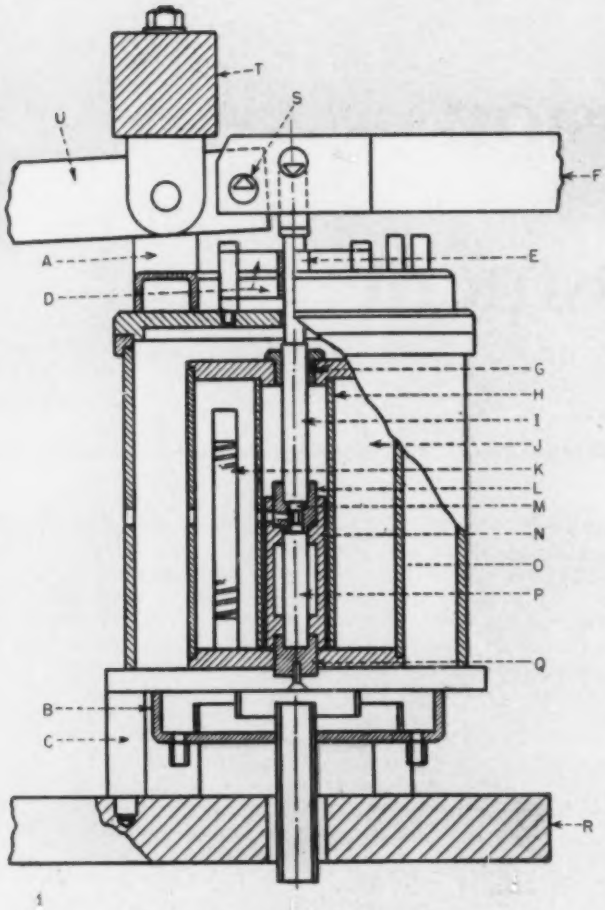
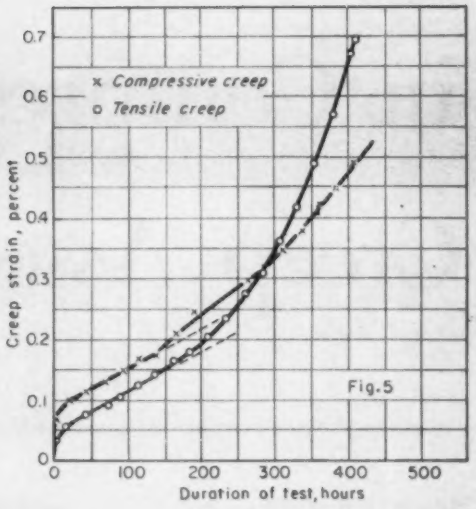
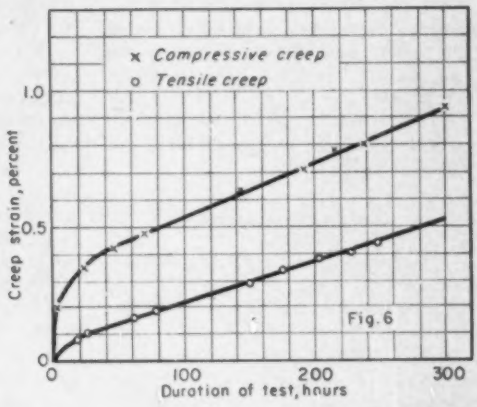


Fig. 4 — A detailed cross-section view showing the arrangement of a compression creep testing machine. The specimen *(M)* is compressed between the two push rods *(I)* and *(P)*.





touches the gage length of the specimen and which is inserted through a hole in the furnace tube and guides. The space *(J)* between the furnace tube and furnace case *(O)* is filled with refractory packing, and a non-inductively wound resistance thermometer *(K)* is supported in the furnace packing and gives control of the furnace temperature to within ±2 F by means of an associated bridge thermostat. The top and bottom of the furnace casing are water cooled, and a steel plunger *(E)* transmits the load to the top push rod. This is moved vertically by sliding in a bearing, with the lateral stability provided by flexture plates *(D)*.

The specimen has a gage portion ¼ in. long and ⅛ in. in diameter, and carries at either end shoulders 0.25 in. in diameter and 0.1 in. thick, with the fillet radius between the gage length and the shoulder being kept as small as possible. If necessary, simple cylindrical specimens can be used. The shoulders are desirable if the size of metal available permits them to be machined, since stress concentrations in the refractory push rods at the point of contact can be minimized. Sometimes at high loads such stress concentrations can cause some spalling of the refractory at the area of contact with the specimen.

At the stresses to which the push rods are subjected in service, recrystallized alumina shows no significant creep at temperatures up to at least 1,850 F. Fused silica creeps appreciably at temperatures of 1,650 F and above, but could be used as push rods at temperatures to 1,470 F. The apparatus can be used for long term tests at 1,850 F, and with a platinum winding, at temperatures up to at least 2200 F. It is relatively easy to modify it to carry out tests in vacuum or in an inert atmosphere by providing a seal between the lid and the casing, and applying the load by means of a sealed flexible bellows surrounding the plunger *(E)* and brazed or soldered to the top lid.

The lowest strain rate which can be satisfactorily measured with this equipment corresponds to a dial gage movement of one division equal to 0.0001 in. per day. This corresponds to a strain rate of 5×10^{-5} per day, i.e. about 2×10^{-6} per hour.

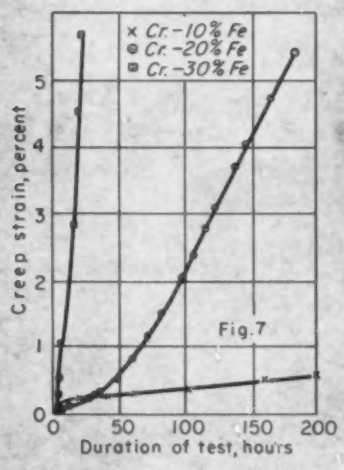
Correlation Between Compressive and Tensile Creep

It is next relevant to consider what correlation there is, if any, between creep under axial compressive stress and creep under axial tensile stress.

Fig. 5 — Correlation between compressive creep and tensile creep for a complex nickel-chromium alloy at 9 T/sq. in. at 1,500 F, showing agreement between the steady state creep rate, and the time to the onset of tertiary creep.

Fig. 6 — Correlation between compressive creep and tensile creep for a high purity aluminum—4 percent copper alloy at 4.5 T/sq. inch at 375 F.

Fig. 7 — Compression creep curves of three chromium-iron alloys at 3T/sq. inch at 1,650 F, showing a variation between the iron content of the alloys and their resistance to deformation.



This point has been investigated on a wide range of materials over a considerable temperature range, with the range covered being for aluminum alloys at temperatures as low as 300 F, to some of the newer high temperature alloys at temperatures as high as 1,650 F.

In general, the creep curve of metallic alloys in compression is similar to that in tension, having the three characteristics of a decelerating primary stage, a secondary stage of fairly constant creep rate, and a third or tertiary stage of accelerating rate. Beyond the initiation of tertiary creep there is, of course, a noteworthy difference between compressive and tensile creep, since, in the latter case, the creep rate accelerates continuously to fracture; whereas, in compressive creep, fracture does not occur, and the creep rate usually goes through successive stages of acceleration and deceleration.

In general, however, it may be said that for metallic materials of reasonable ductility, the compressive creep test gives results that agree well with tensile creep tests in the secondary, steady state creep rate, and usually in the time to onset of tertiary or accelerating creep. Since these are the most important parameters in defining the creep resistance of the material, the compressive test thus enables a good assessment of the probable behavior in tensile creep to be made. Figs. 5 and 6 are typical examples of the results obtained.

It must be emphasized that such good correlation is only obtained, and is only to be expected when the creep deformation is small, and the results are relatively little complicated by variation in stress due to changes in the cross sectional area of the test piece. At large deformations under constant load, the stress in a tensile test is significantly increased due to reduction in cross sectional area, while in compression the converse is true. Creep will occur at an increasing rate in tension and at a decreasing rate in compression because of this factor alone. For this reason the correlation between tension and compression creep tests is not good for soft materials which undergo deformation as high as 10 percent or more during the course of a creep test. Fortunately, in examining the properties of creep resistant alloys, the deformations involved are only of the order of one or two percent or less; and it has been found that for deformations of this order, the correlation between compression and tensile creep tests is relatively unaffected by this variation from conditions of constant stress.

Two points of difference between the results of compression and tension creep tests should be mentioned. First, the extent of deformation in the initial or primary stage of creep is larger in the compression test than in the tension test. The compression test should not be used here to predict the probable total deformation in a given time when under tensile stress, except in the special case where deformation in the primary creep stage is small by comparison with that found in the secondary stage. The reason for this slight discrepancy is believed to be a slow bedding down which follows loading at the various contact surfaces in the compression system. The possibility of a genuine difference between compressive and tensile creep in this stage of the creep curve cannot, however, be ruled out.

The second point of difference is more important since, unless it is properly appreciated, it is possible to be misled by the results of compressive creep tests. This relates to the testing of relatively brittle materials in which the presence of stress concentrations such as casting defects, grinding cracks, etc. may initiate failure under axial tension. These defects have relatively little influence on the material when it is under compressive stress, so that the compression creep test measures the intrinsic creep resistance of the material. In a tension creep test, however, premature failure may occur due to notch effects, and the probability of this cannot be foreseen from the compression test. In brittle materials, therefore, the compression test only compares their intrinsic creep behavior, and it is necessary to carry out supplementary tensile creep tests in order to determine the importance of the factors that will cause premature failure.

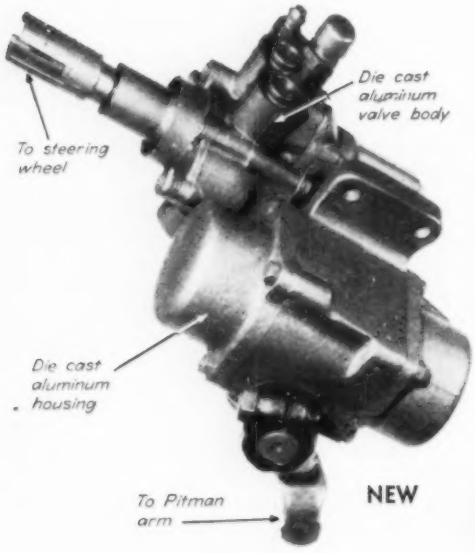
The compression creep test should not be used for assessing the creep properties of materials whose structure consists of hard particles bonded by relatively small quantities of a relatively plastic matrix, e.g. bonded carbides or other refractory metal combinations of low metal content. In such materials the compression and tension creep behavior may be quite different. In compression at high temperatures, a small creep strain results in the flow of the relatively plastic metal between the refractory particles with the result that the latter come into intimate contact, and creep is slowed down or stopped altogether. In tension, on the other hand, the matrix phase determines the creep properties throughout the test; and failure, when it occurs, is through the relatively plastic matrix.

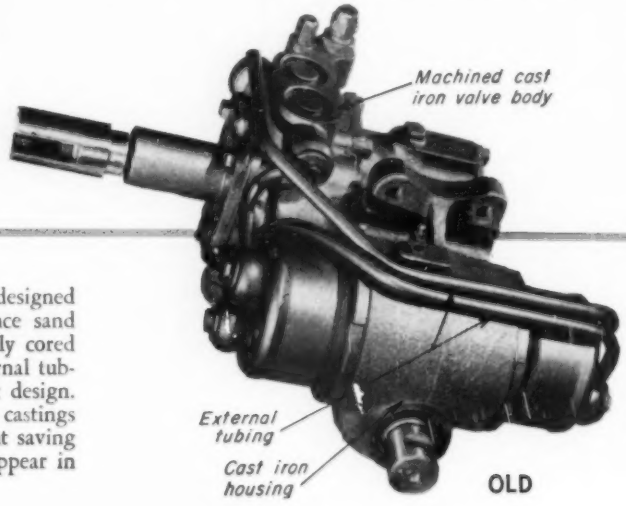
To sum up: The correlation between compression and tension creep is such that, for metallic materials, compression creep tests which can very easily be carried out on miniature specimens, can be used to give an accurate comparison between the creep rate at high temperatures of various alloys, or of various specimens of the same alloy. It is ideally suited for tests on material which is only available in limited quantity, and for surveying the creep properties of alloys being made experimentally on a small scale. As an example of its use in the latter connection, Fig. 7 shows compression creep curves of three chromium-iron alloys at a stress of 3 tons/sq. inch at 1650 F. The tests disclose a considerable and systematic variation between the iron content of the alloys and their resistance to deformation under these conditions.

Using New Materials

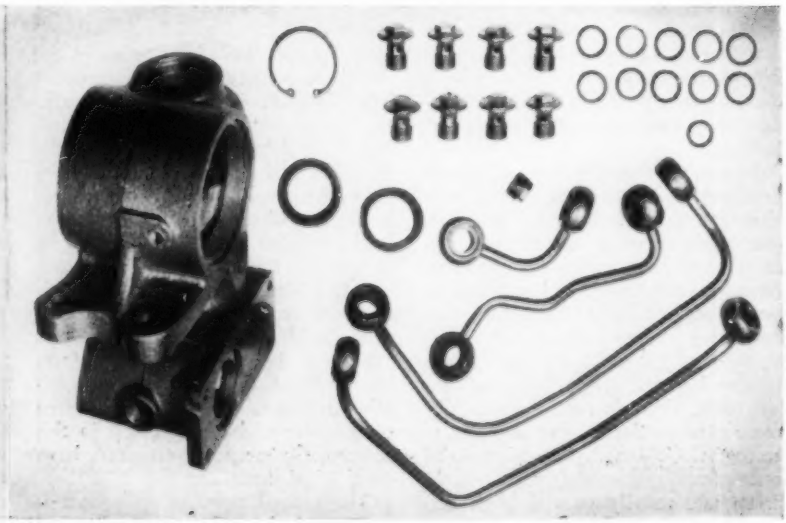
To use new materials and production processes, engineers at the Gemmer Manufacturing Company, Detroit, Michigan, redesigned their "Hydraguide" power steering unit (Product Engineering, March, 1951, p 96). The new design reduces the number of parts by 30 pieces, the weight by 25 percent and the cost appreciably.

Most significant changes: sand cast aluminum for the housing and aluminum die casting for the valve body instead of iron castings. With the new technique,





HYDRAGUIDE power steering units redesigned for more economical manufacturing. Since sand cast aluminum housing could be internally cored for fluid passages, engineers avoided external tubing to make a cleaner and more compact design. Die cast aluminum used instead of iron castings in other places produced an overall weight saving and cost reduction. The new unit will appear in late 1953 Chrysler Corporation cars.



CHANGE from malleable cast iron housing (left) to aluminum sand cast housing (right) eliminated 20 parts. Shown here are the parts required to seal the new and old housing. Because aluminum housing has internally cored oil passages, the new design needs no external tubing; for sealing it uses only seven O-rings.

IN NEW PRODUCTS

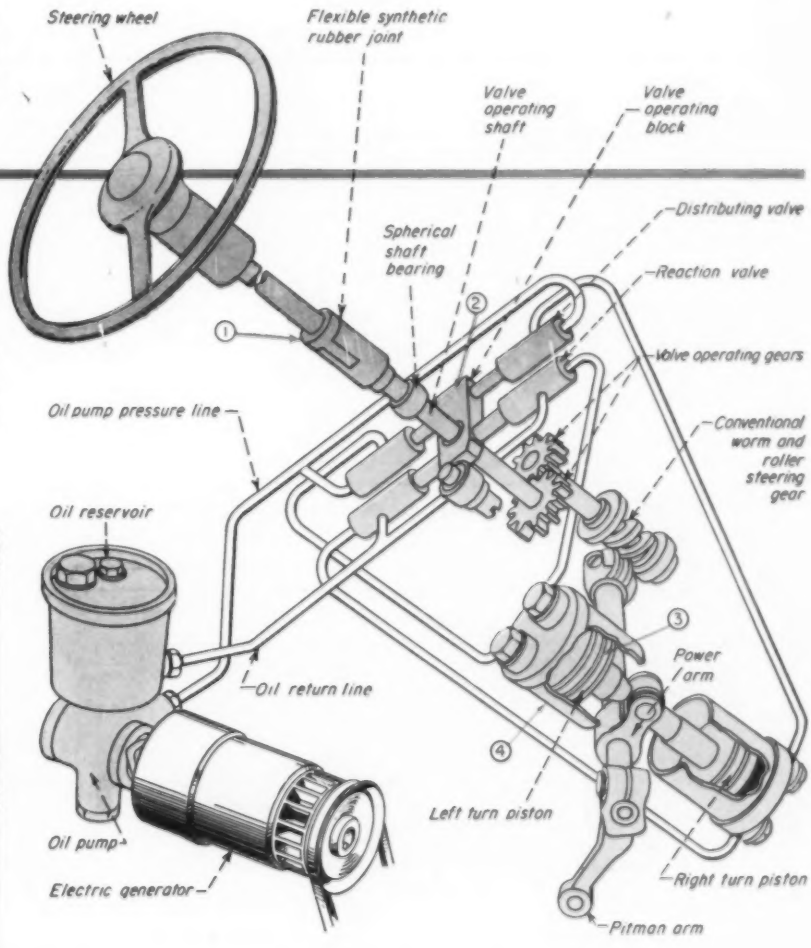
in Design Lowers Production Costs

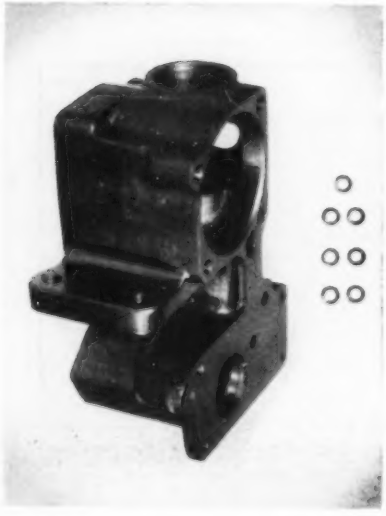
internal coring for hydraulic fluid passages replaces external tubing, and 25 parts associated with it. Aluminum reduces housing weight by 58 percent and manufacturing economies cut costs by a similar percentage. Previously machined from an iron casting, the diecast valve body virtually does away with machining with accompanying cost saving. Here too, aluminum reduces weight by 70 percent.

Other changes were made in the cylinders, power piston ends, valve operating block, the piston seal, column and driver and worm adjustment. For example, designers realized a 60 percent economy by using powder metallurgy to make the valve operating block instead of machining it out of steel. A new piston seal increases life as well as reducing the number of parts required.

Manufacturing economies in finishing operations are illustrated on the next two pages. Those portions in color indicate areas that require machining.

SCHEMATIC of old unit with arrows indicating some changes: (1) Column and driver is now forged as one piece instead of tubing, butt welded to a machined driver. (2) Valve operating block is made from powder metallurgy; formerly it was machined from steel. (3) Power pistons are die cast in two aluminum components to replace three individually machined castings. (4) Piston seal has rubber section backed up by injection molded nylon ring instead of four phenolic rings.





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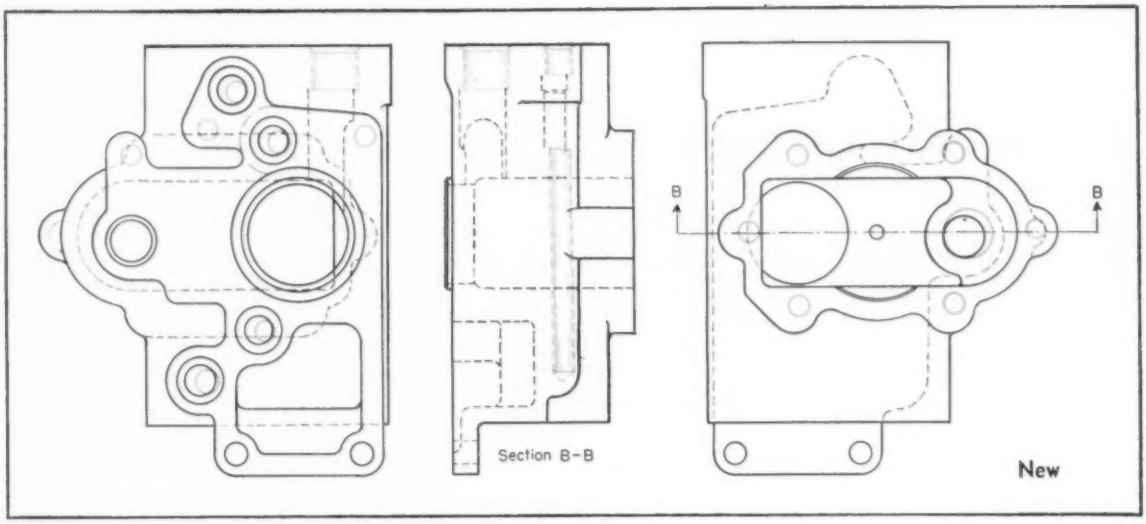
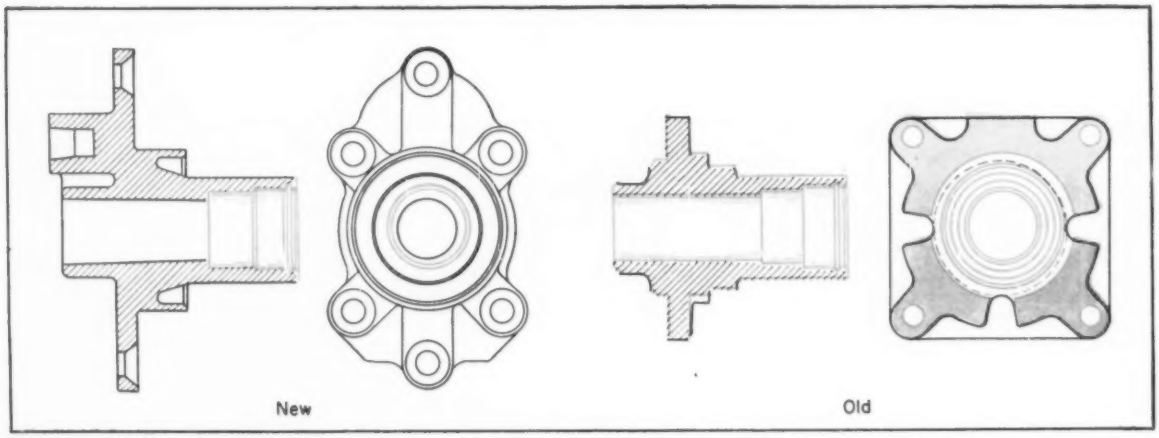
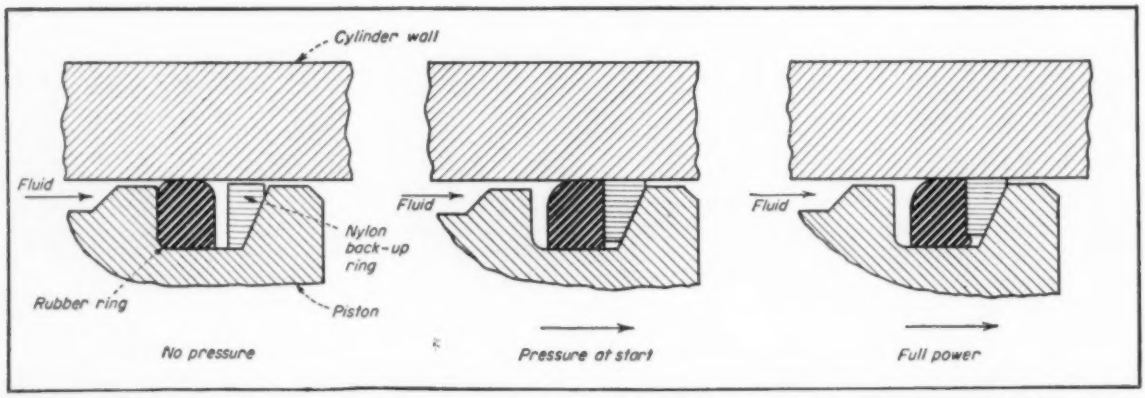


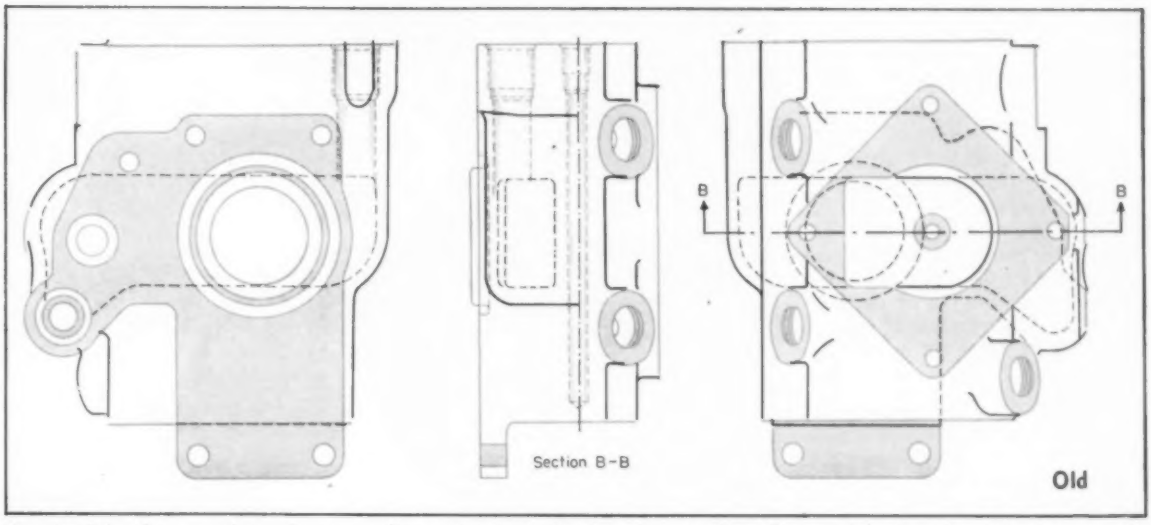
PRODUCTION DRAWINGS of valve body, show the extent of savings possible because of reduced machining



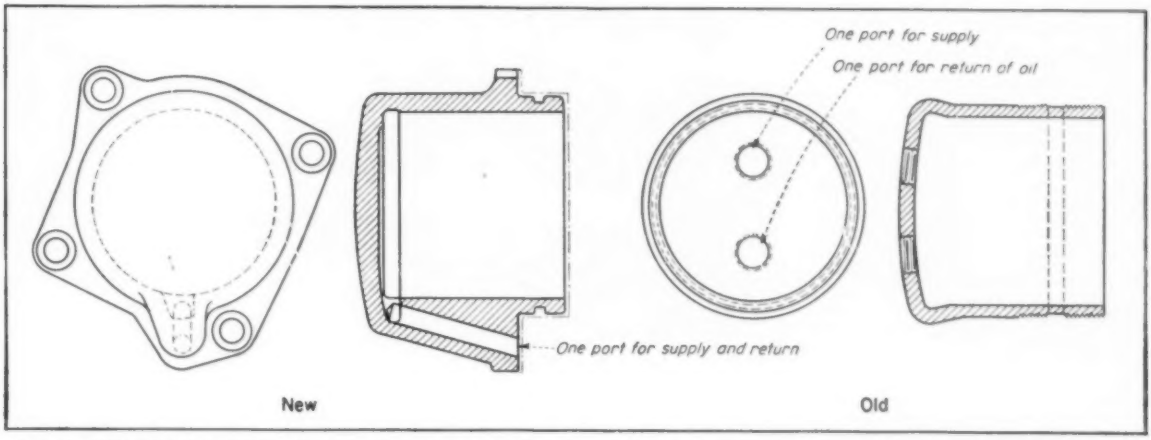
VALVE BODY CAP, new aluminum die cast design and old iron casting. Areas in color indicate surfaces that need machining operations. Switch to new technique practically eliminated finishing operations.



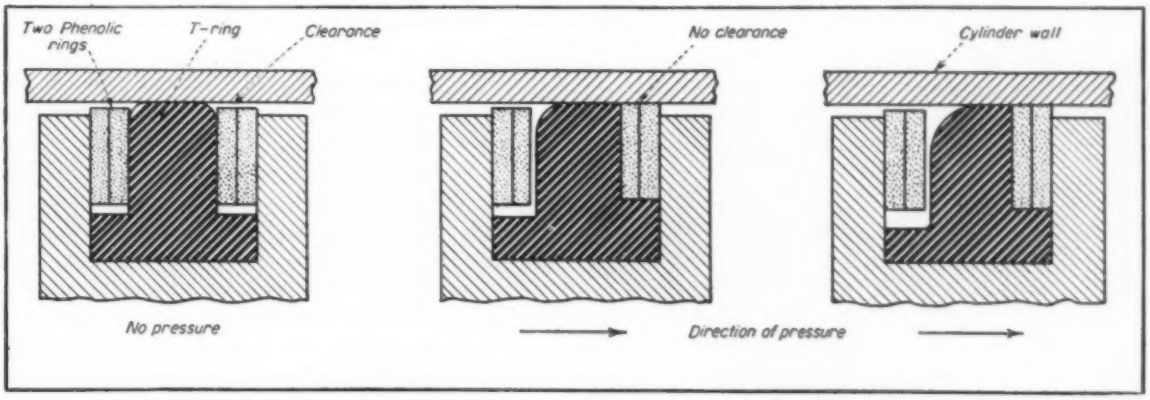
NEW PISTON SEAL (above) uses only two parts. Under pressure rubber ring forces the nylon against the cylinder wall centralizing piston and preventing rubber extrusion. With no pressure, the new nylon ring prevents metal contact.



Permitted by the use of an aluminum die casting instead of an iron casting. Too, weight is reduced by 70 percent.



IN POWER CYLINDER, eliminating external tubing, permitted using a single port for supply and return of oil. New cylinder, cast from grey iron, has single cored part. Old cylinder required two tapped ports.



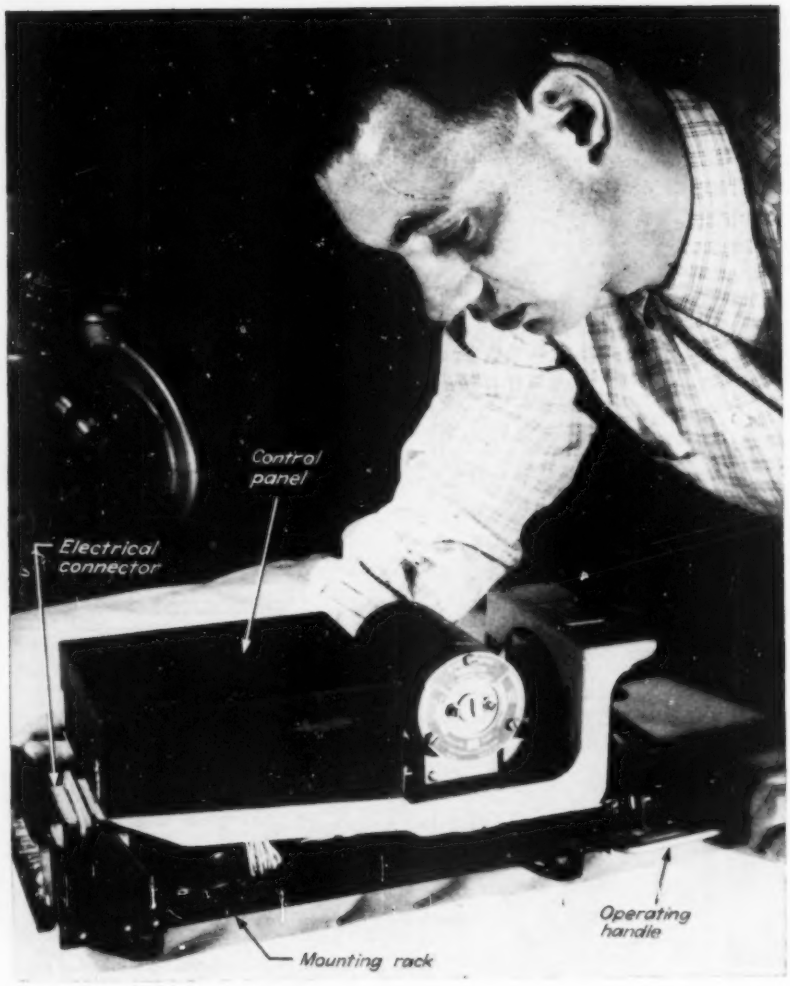
between piston and cylinder even under high radial loads. Old seal (above) used four phenolic back-up rings and a rubber T-ring made by Green-Tweed Co. Pressure acting on the T-ring forced the plastic rings against the cylinder wall.

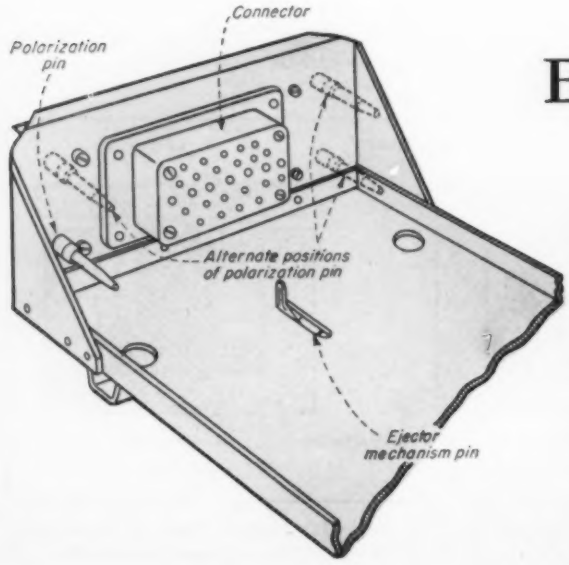
MOUNTING RACK with control panel in place. Technician has pulled handle to disengage panel from electrical connector on rack.

TO REMOVE PANEL: as handle is moved to the open position, toggle causes ejector pin to retract, pulling the panel with it. This breaks the electrical connection. As the pin comes out from under the crosspiece, it falls out of the hole in the panel base because of gravity. Panel can be lifted out by hand.

TO INSERT PANEL: as handle is moved to the closed position, toggle forces the ejector pin forward against the cross piece. Radius at end of ejector rod rides against cross piece and forces pin upward into hole in the panel base. After it moves upward, the pin rides forward carrying the panel to engage the electrical connector.

POLARIZATION PIN prevents mounting incorrect control panel on rack (below). Ejector pin engages panel and moves it toward or away from connector when handle is operated. If wrong panel is mounted, polarization pin prevents engagement of connector or ejector mechanism. Note optional position for pin to increase versatility.

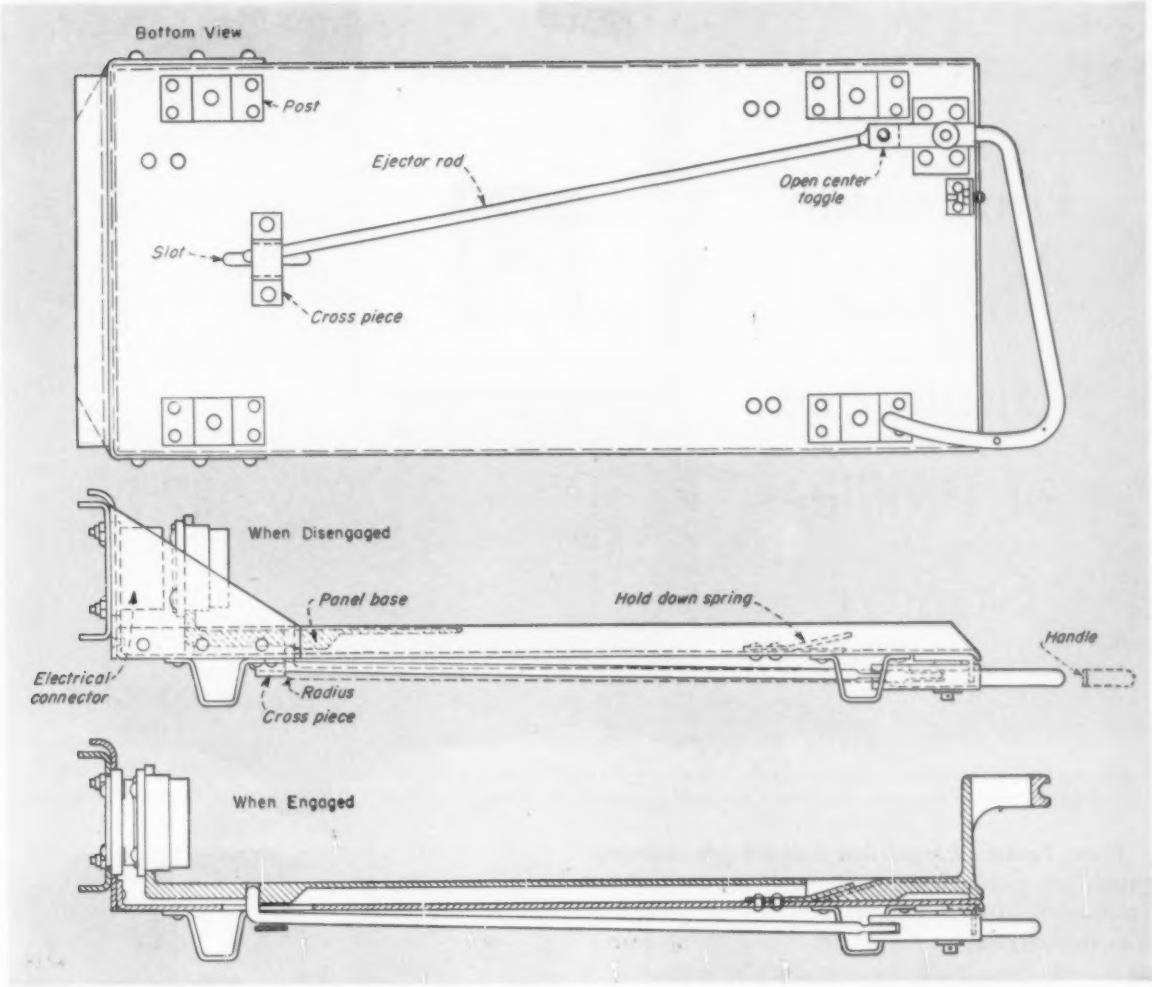




Ejector for Removal of

To simplify maintenance of electronic components, B. O. Austin, Westinghouse Electric Corporation, designed this mounting rack with ejector mechanism which permits the easy removal of an entire subassembly. Components of this device include a tray, electrical connector, locating or polarization pin, panel fastening device and panel ejector device.

The ejector mechanism, which is exceedingly simple, relies on gravity to unlock the panel. After retracting the panel to break the electrical connection, the ejector pin drops out permitting the panel to be lifted off the rack. A polarization pin is located so that only the correct panel can be returned to the rack, preventing installation

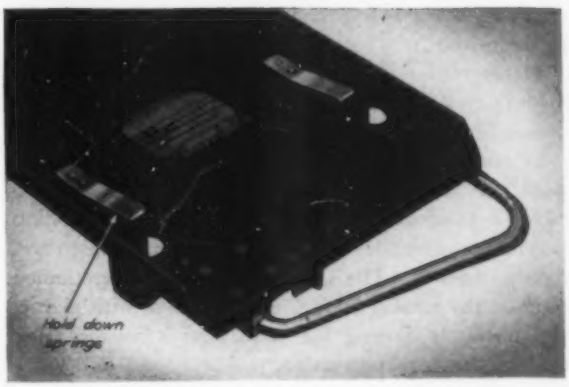


Electronic Components Uses Gravity

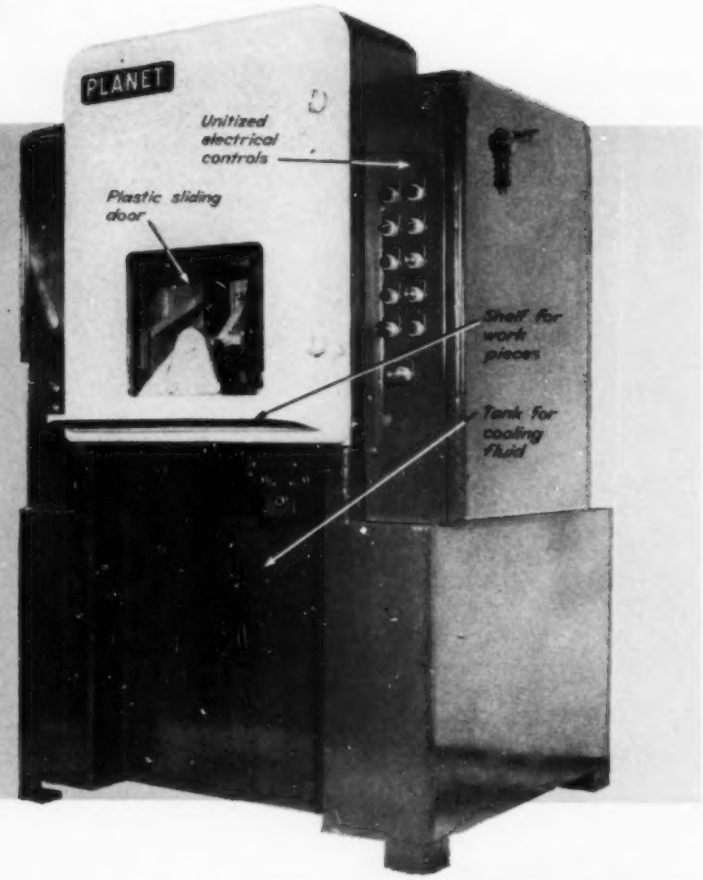
errors. When engaged, leaf springs hold the panel against the electrical connector with positive force.

The ejector mechanism develops a 30 lb disengaging force with an eight lb pull on the operating handle. Made of aluminum, the rack is light enough to serve in aircraft as a platform for a-c or d-c control panels or regulators of the plug-in type. In this application, the tray is mounted permanently in the airplane.

Electrical receptacle, in the rear, can be removed from the rack for harness wiring at a remote location. Then the connector and its wiring harness are assembled to the previously installed rack without a soldering operation in close quarters.



Unitization for Easy Manufacture of Profile Grinder

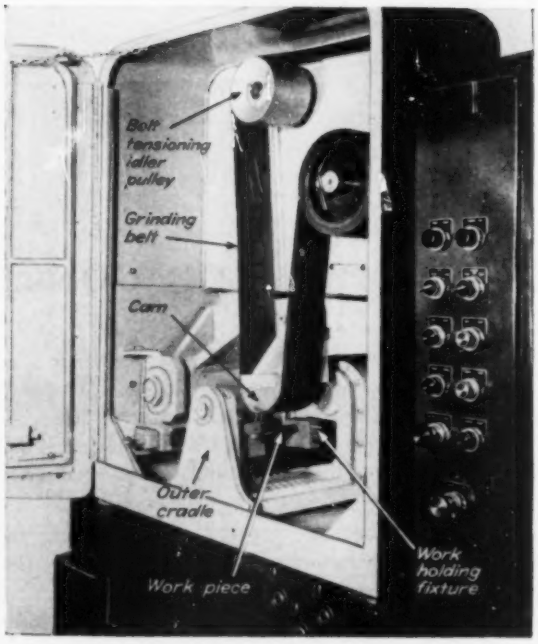


Planet Products Corporation designed this conjugate profile belt grinder in unit sections so that the machine could be manufactured economically in small quantities. Too, the company wanted to protect as much apparatus as possible from the destructive effects of abrasives.

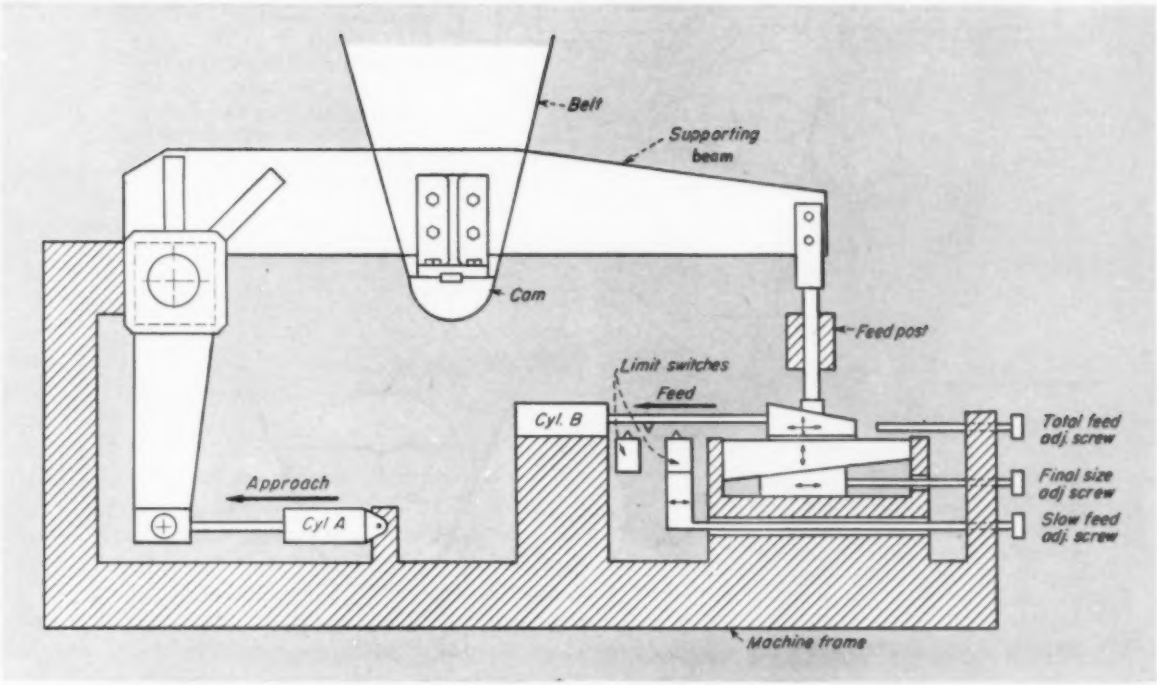
To do this, Planet engineers divided the machine into five major sections. In the electrical section, all controls are centralized in the right hand panel built as a separate unit. All hydraulic controls are interconnected in a central panel on the left hand side of the machine. Power equipment like motors and pumps are grouped in the rear of the machine for easy maintenance. The entire bottom of the unit itself serves as a reservoir for coolant. And only the grinding mechanism and work fixture are in the cabinet.

Planet found that unitization not only solved their manufacturing problem but also provided a clean simple design for a machine with a complicated function.

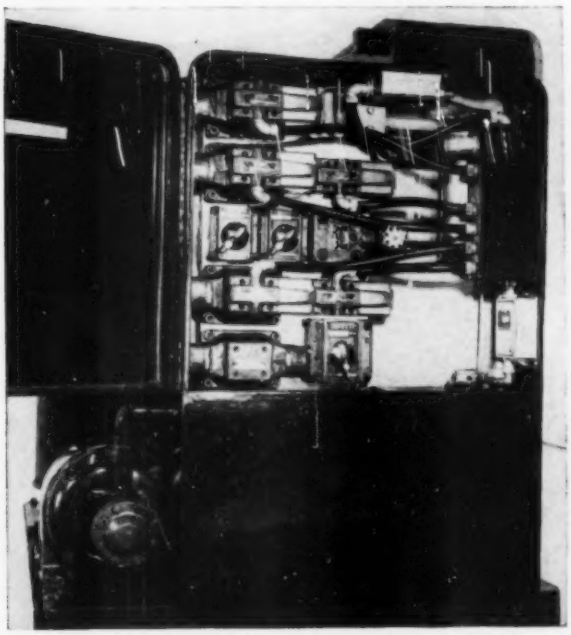
In operation both the grinding mechanism and the work move relatively to each other to form the complicated shape of turbine blades and buckets. A grinding cam moves vertically to feed while the work sweeps and rotates under it. The shape of the cam is determined right on the grinder by facing a cam blank with plastic, and manually moving the blank and a master blade through the grinding motion.



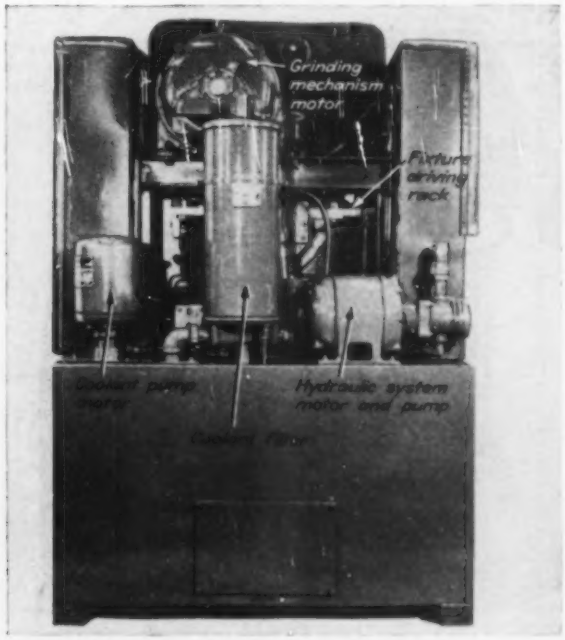
GRINDING MECHANISM. Cam, shaped to generate the desired profile, is lowered hydraulically into work for cutting feed. At the same time sweep mechanism oscillates piece under the master form.



THREE WEDGES supply feed and feed adjustment. Hydraulic cylinder *A* moves beam supporting master form until the feed post contacts the top wedge. Cylinder *B* moves top wedge to feed cam into work during grinding.

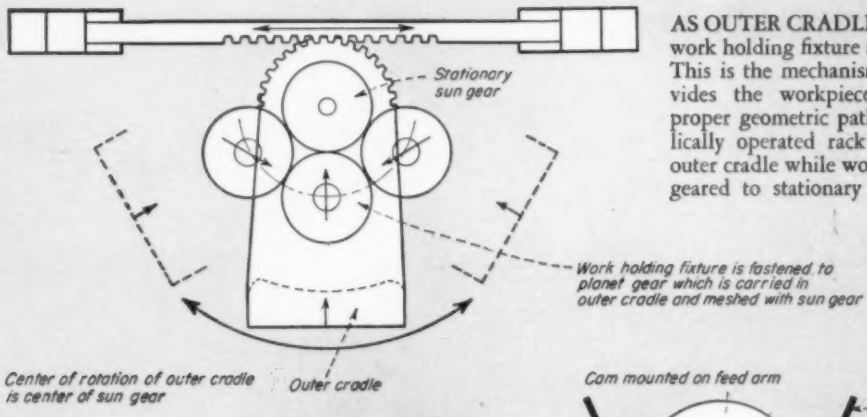


HYDRAULIC CONTROLS are assembled and interconnected in one panel through the use of a manifold plate. As in other sections of the machine, these components can be assembled independent of the machine or other sections.



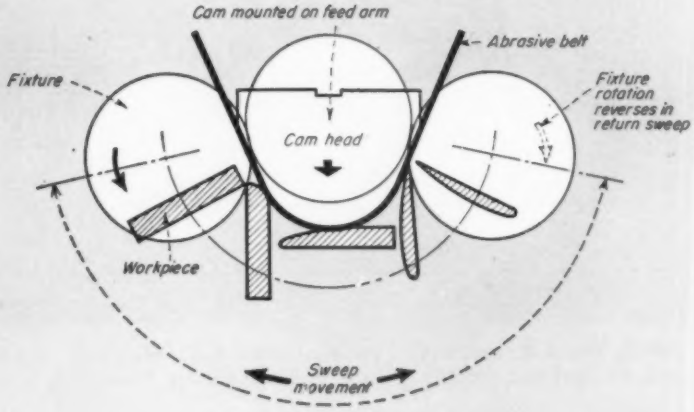
MOTORS AND PUMPS, located in the rear for easy maintenance, make up power section. During manufacture they can be placed on the machine while electric and hydraulic control panels are fabricated as separate units.

Profile Grinder (continued)


Stationary sun gear
Work holding fixture is fastened to planet gear which is carried in outer cradle and meshed with sun gear
Center of rotation of outer cradle is center of sun gear
Outer cradle

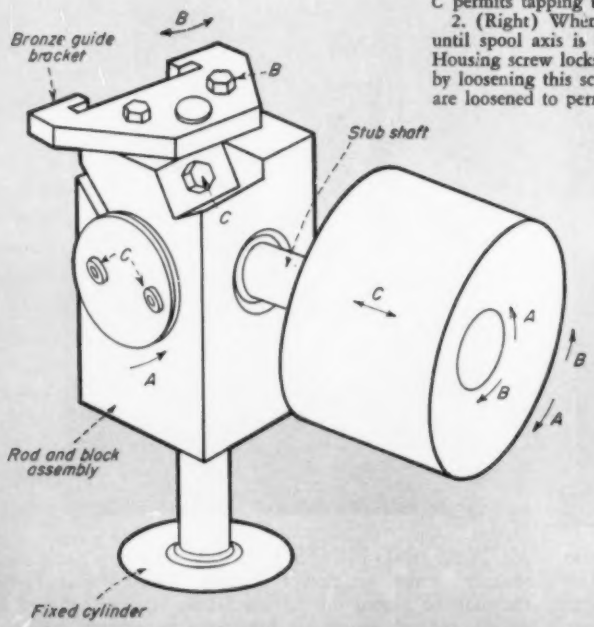
AS OUTER CRADLE SWEEPS, work holding fixture also rotates. This is the mechanism that provides the workpiece with the proper geometric path. Hydraulically operated rack moves the outer cradle while work fixture is geared to stationary sun gear.

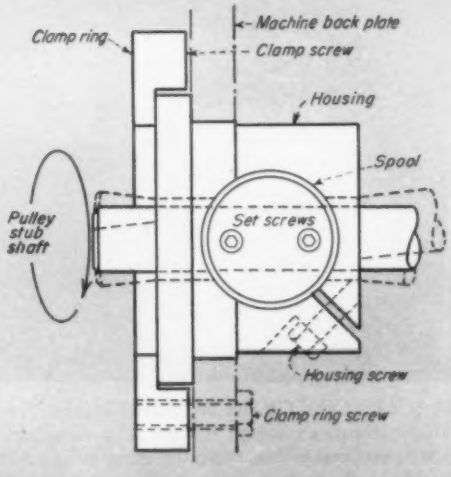
SKETCH SHOWS (at right) how cam feed, sweep movement and work fixture rotation combine to provide relative motion so that desired profile is ground on blade. Machine can remove stock from Nimonic forgings at the rate of 0.001 to 0.003 in. per second.



THERE ARE TWO TYPES of idler pulley mechanisms to permit three dimensional adjustments for belt tracking. →

1. (Left) Loosening screw *A* allows horizontal spool to roll for vertical adjustment. Loosening cap screws *B* frees the outboard Oilite bronze guide bracket so that the tensioning piston, rod and block assembly rotate within the fixed cylinder to provide horizontal adjustment. Loosening set screws *C* permits tapping the non-rotating stub shaft into proper axial position.
2. (Right) When clamping screw is loosened, housing may be rotated until spool axis is perpendicular to desired plane of pulley adjustment. Housing screw locks pulley shaft at desired angle; angle may be changed by loosening this screw and rotating pulley shaft. Set screws in the spool are loosened to permit axial movement of the shaft.





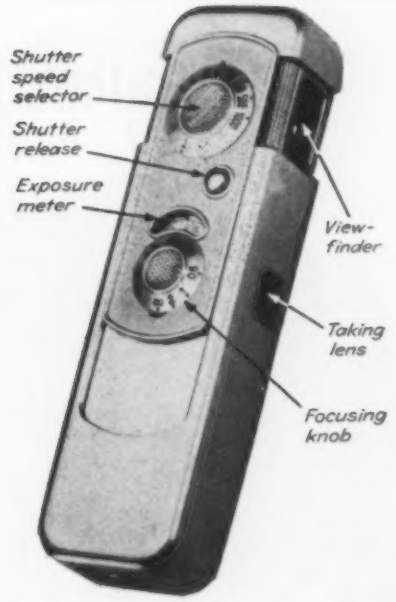
Tiny Camera Has Fixed Depth of Field

In this midget camera, Minox GmbH, Wetzlar, Germany, has crammed 183 parts, many of them precision components, into a space $\frac{5}{8}$ x $1\frac{1}{8}$ x $3\frac{1}{8}$ in. This cigarette lighter-size camera which takes pictures on 8 mm film, weighs less than $2\frac{1}{2}$ ounces.

This is how the small size is used to picture taking advantage. A spherical pressure plate exerting a force just over one lb curves the film at picture taking so that it matches the curvature of the field of image. This along with a f:3.5 lens, focal length 15 mm, automatically provides correct focus from six ft to infinity. As a result, there there is no need to close the lens aperture for sharp focus and there is only one aperture opening, f:3.5.

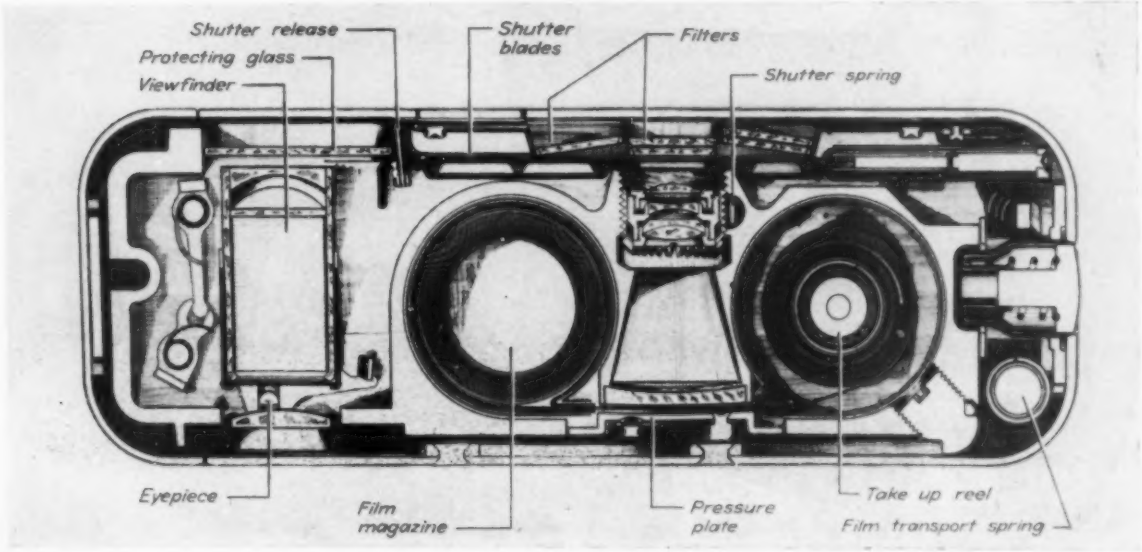
One motion, "pulling the case apart", cocks the shutter, advances the film, advances the exposure indicator, and opens the taking and viewing lenses. Springs return the camera to picture taking position. To make an exposure, the operator pushes the shutter release pin.

Other features of the camera: built in filters, light-tight film magazine holds 50 exposures, focus adjustable from 10 in. to infinity, and lens sunk into the body so it acts as a built-in sunshade and protects the glass.



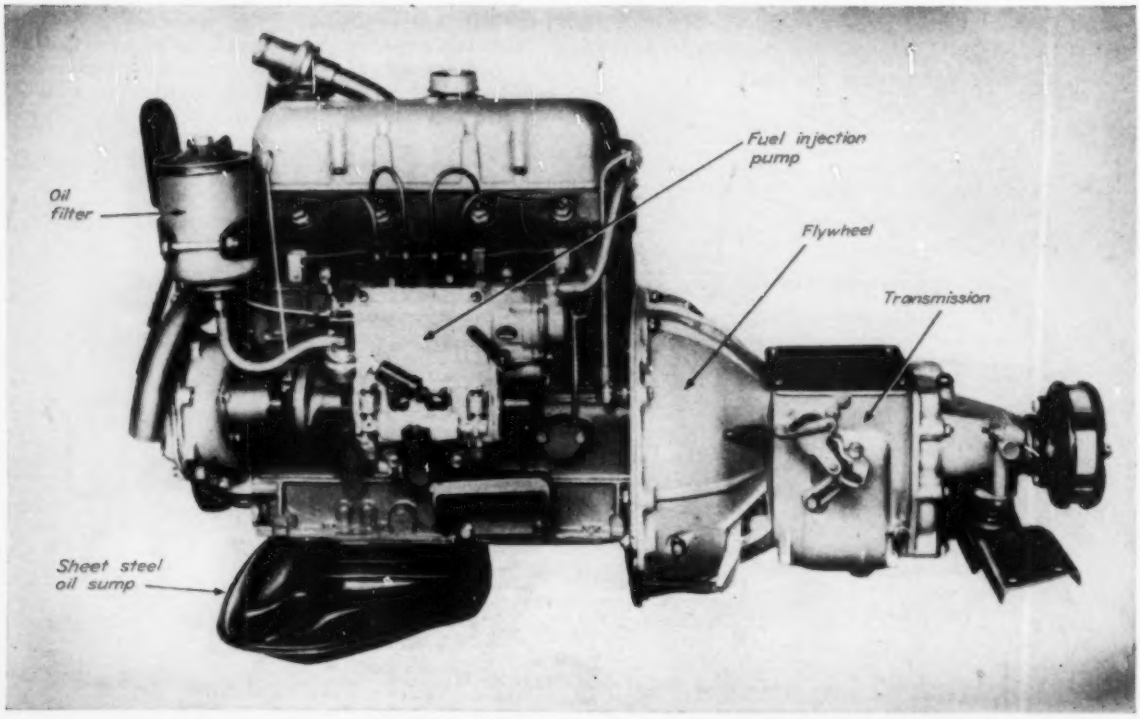
MINOX CAMERA turns out a negative 8 x 11 mm. With aluminum body, it weighs less than $2\frac{1}{2}$ oz. Speed selector indicates range of shutter speeds from time to 1/1000 sec. Photographer can operate camera with one hand and take pictures indoors or out-of-doors. Midget camera illustrated above is full size.

ENLARGED VIEW shows components of camera. Male and female mechanism at far left provides spring action to return camera to picture taking position after case is extended to wind film and cock shutter. Conventional spring trigger found in German cameras trips the shutter.



Italian Lightweight Diesel Engine

NEW LIGHTWEIGHT DIESEL ENGINE powers this delivery lorry at speeds up to 45 mph. Unusual features include a 24 v electrical system, and fuel consumption 35 percent less than that with a gasoline engine of similar performance. Because of smoother combustion, engineers were able to design lighter parts, reducing vehicle weight without changing materials.



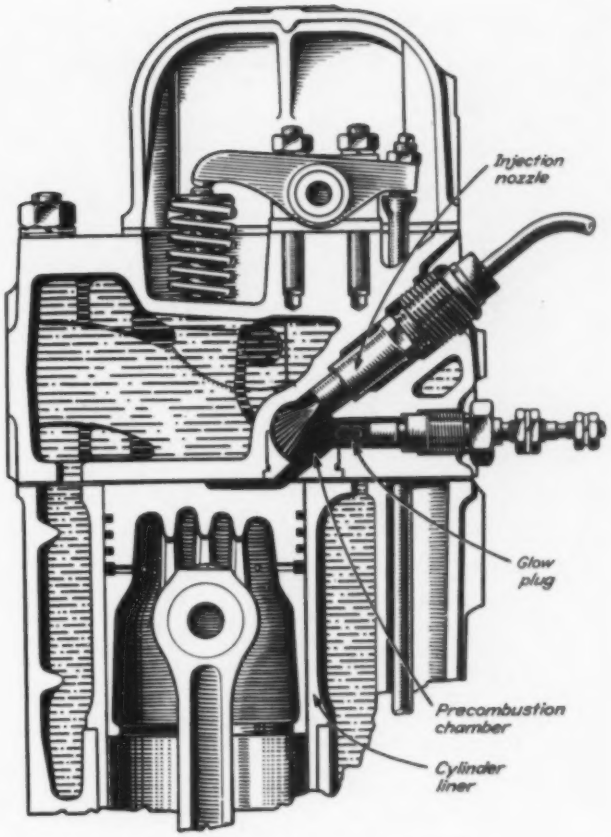
Powers Truck

In studying this new Fiat lightweight diesel truck engine, the most startling fact is it's horsepower rating—40 hp at 3,200 rpm—lower than any American passenger car engine. But the Fiat is designed for economical continental operation. Typical performance: top speed, 45 mph; fuel consumption, 25 miles per American gallon.

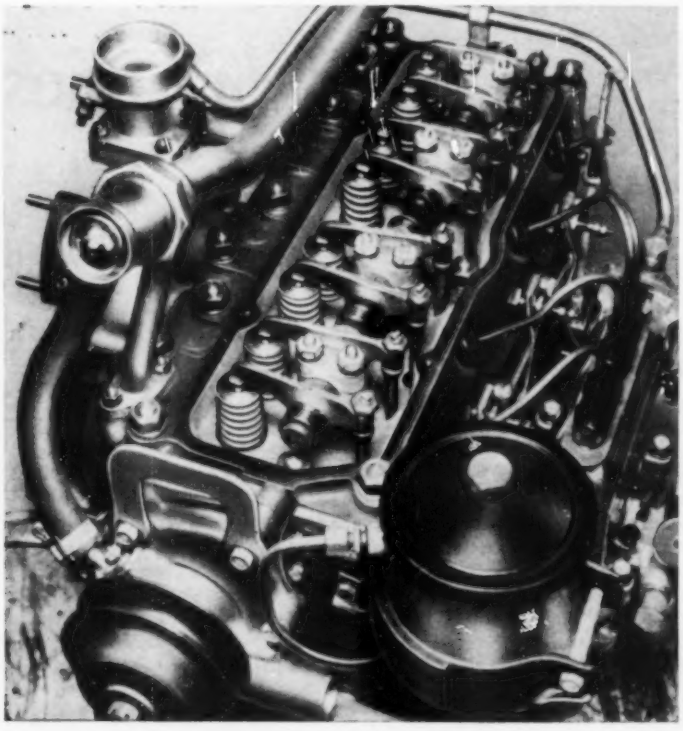
Primarily responsible for the top economy is the combustion chamber design. Single jet ejectors direct fuel into a Ricardo turbulence precombustion chamber. This represents a major change for Fiat who has previously used multijet injectors.

According to the Italians, the pre-combustion chamber provides smoother power to the pistons so they were able to reduce the weight of the engine to 416 lb by designing members to withstand lower loads.

Mechanically the engine has four cylinders in line. Cylinder and cylinder heads are cast iron; aluminum pistons use two compression and two oil scraper rings; main bearings are made of sheet steel with lead-indium antifriction linings.



COMBUSTION chamber design. Single nozzle injectors send fuel into comet-shaped pre-combustion chamber. Nozzles are as easy to change as spark plugs in a gasoline engine. Glow plugs facilitate starting particularly in cold weather. Cylinder liners, easily replaced, are in direct contact with cooling water to improve heat dissipation.



FOUR CYLINDER Fiat disel engine (far left) weighs only 416 lb, 10.4 lb per hp. Much smaller than U. S. truck engines, it has a 20:1 compression ratio, conventional helix-metering fuel injection pump, camshaft driven gear pump for lubrication, and centrifugal vane pump for cooling with thermostatic temperature control.

OVERHEAD VALVES, one inlet and one exhaust, are actuated through rocker arms and push rods from the three bearing camshaft located in the engine base and driven by helical gears off the flywheel.

Table I—Structure and Handling Characteristics

Material	Structure		Handling	
	Uni-cellular	Non-Uni-cellular-	Foamed-in-Place	Molded and Extruded Foams
Polyvinylchloride	x			x
Polystyrene	x			x
Butadiene-Styrene-Acrylonitrile	x		x	
Cellular Cellulose Acetate	x			x
Phenolic		x	x	
Epoxy-Resins		x	x	
Polyester		x	x	
Furane		x	x	
Urea		x		x
Isocyanate		x	x	

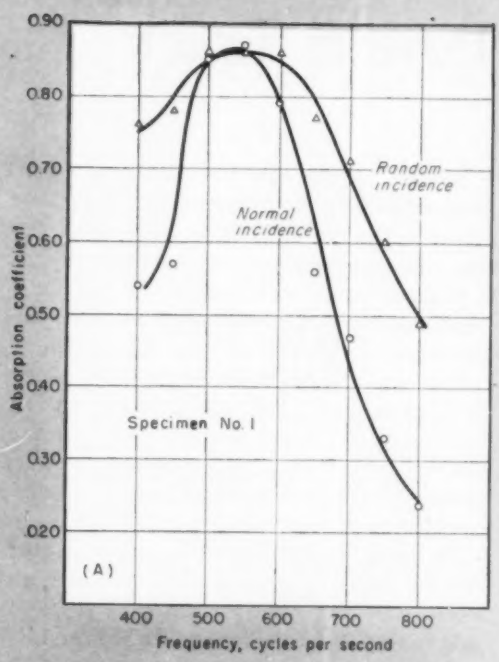


Fig. 1—Sound absorption coefficient at different frequencies of two specimens of a soft grade of expanded polyvinyl chloride. (A) Specimen No. 1, Table III.

Table II—Thermal Conductivity of Insulation Materials

K = Conductivity, Btu/hr/sq ft/deg F/in

Material	Density, lb per cu ft	K Factor average
Styrofoam 22	2	0.23 to 0.30
Flotofoam	0.8	0.18 to 0.21
Polyvinyl Chloride foam, Type II	5	0.23
GE Phenolic foam	3 to 5	0.24
GE Phenolic foam	7 to 10	0.28
Glass wool	4	0.26
Hair felt	9	0.26
Rock wool	6	0.27
Corkboard	7	0.28
Fiberboard	18	0.34

Properties

H. J. STARK
Materials Engineer,
Bureau of Ships, Department of the Navy

Recent engineering test data on several plastic foams or cellular plastics used in numerous naval applications. Data are of interest to design engineers in general and are significant enough to indicate utilization of plastic foams in many design and development projects.

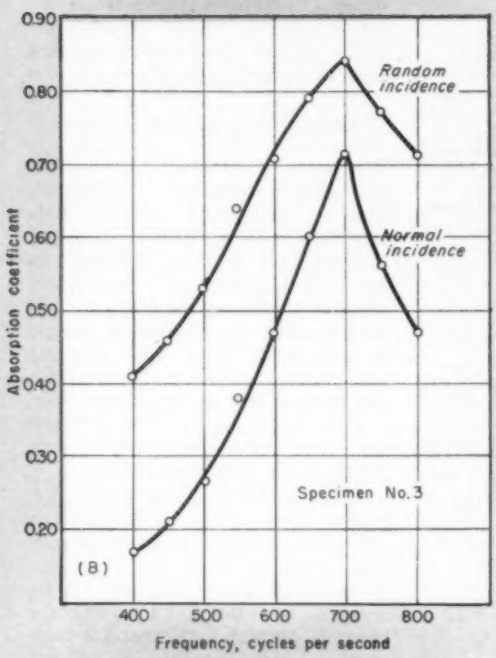
MOST CELLULAR or foam plastics are conventional or modified plastic materials that have been expanded in volume with a gas such as nitrogen, carbon dioxide, methyl bromide, propane, freon, water vapor, or air. The density, structure, buoyancy characteristics, and strength properties of foam plastics are controlled during production. In the foam structure, the cells may be open and interconnecting or closed and not interconnecting.

These low density materials are used in engineering applications to obtain:

1. Light-weight structural space filler
2. Buoyant marine structures and equipment
3. Light-weight stiff panels of sandwich construction
4. Cold space thermal insulation
5. Residential and industrial thermal insulation
6. Padding on instrument panels and for body protection
7. Sound and vibration isolation.

Selection of a plastic foam for a specific application is generally influenced by:

1. Physical and chemical properties of the resin or plastic.
2. Physical properties of the cellular plastic; such as strength, and resistance to water or other fluid penetration.
3. Ability to be foamed in place.



Absorption coefficient for this sample is high between 500 and 600 cps. (B) Specimen No. 3, Table III. Peak value of coefficient for this sample is at 700 cps.

Table III—Sound Absorption Coefficient Measurements. Measured at 512 cps Using the Open Hollow Tube Method

Material	Thickness, in.	Coef., avg. value
1. Expanded polyvinyl chloride, soft	15/16*	0.85
2. Phenolic foam	1	0.66
3. Expanded polyvinyl chloride, soft	7/8**	0.48
4. Phenolic foam, S-1028	15/16	0.47
5. Fibrous glass laminate, polyester resin	3/8	0.4
6. Fibrous glass laminate, polyester resin	15/16	0.4
7. Phenolic foam, Bakelite	15/16	0.38
8. Phenolic foam, Bakelite	1	0.35
9. Fibrous glass laminate, polyester resin	1/4	0.3
10. Phenolic foam, Westinghouse	1	0.26
11. Phenolic foam, Westinghouse	15/16	0.26
12. Corkboard	15/16	0.22
13. Styrofoam	1 1/16	0.12
14. Expanded Royalite	29/32	0.04
15. Expanded polyvinyl chloride, medium soft	1	0.04
16. Balsa wood	7/8	0.04
17. Cork, phenolic bonded	1	0.04

* See Fig. 1 (A) for coefficients over a range from 400 to 800 cps.
** See Fig. 1 (B) for coefficients over a range from 400 to 800 cps.

and Characteristics of Foamed Plastic Materials

4. Availability in extruded sections or molded forms.

Several foamed plastic materials are classified in Table I according to structural characteristics and processing techniques. This discussion will not be concerned with all the materials mentioned in Table I. The data to be presented will cover only those with which the author has had some experience in ship and flotation equipment applications. These materials are polyvinyl chloride foam, polystyrene foam, cellulose acetate foam, butadiene-styrene-acrylonitrile foam, phenolic foam, and polyester foam. These data are of interest to design engineers and are significant enough to indicate their utilization in many projects.

Naval applications for foamed plastic materials are numerous, they include life floats, buoys, life preservers, cushions, cold weather clothing, submarine and vehicle insulation, gaskets for refrigerating doors, and ships void space filling materials.

Thermal Insulation and Sound Absorption

Utilization of the thermal insulating and sound absorbing properties of many of the foam plastics offers large potential fields of application that are yet to be explored.

Thermal conductivities of phenolic foam, vinyl foam, urea foam, Styrofoam, and a few conventional thermal insulating materials are given in Table II. The cellular plastics are good thermal insulators but their cost may be restricting their further extensive usage. The vinyl foams and Styrofoam materials have low moisture and water absorption properties, consequently in damp and moist applications the subsequent increase in thermal conductivity is small when compared with that of insulating mate-

Table IV—Range of Properties of Polyvinyl Chloride Foams

Property	Type			
	Soft	Medium Soft	Firm	Hard
Load to compress 25 percent, psi	1.1 to 2.9	3.6 to 10		
Ultimate compressive strength, psi			15 to 63	136 to 156
Density, lb per cu ft	3.8 to 6.5	2.9 to 8.2	3.0 to 6.9	11.4 to 13.6
Water absorption, lb per sq ft	0.004 to 0.10	0.014 to 0.15	0.01 to 0.9	0.008 to 0.012
Compression set, percent	5.9 to 55	5 to 60	3 to 60	
Volume loss on heat-aging, percent	5 to 44	10 to 52	2 to 26	
Flame duration, sec	0 to 28	0 to 10	0 to 8	0
Length of char, in	1.38 to 6	0.75 to 6	1 to 3	0.75
Oil resistance	No softening or swelling	No softening or swelling	No softening or swelling	
Tensile strength, psi	21 to 28	39 to 120	81 to 262	

Table V—Properties of Commercial and Experimental Grades of Styrofoam

Property	Commercial Grade	Experimental Grades					
		A	Large Cell	C	Small Cell	Fire Resistant	
Ultimate compressive strength, psi	27	0.72†	18	216‡	140†	104	106
Density, lb per cu ft	1.6	2.3	4.6	3.7	3.8	3.8	3.7
Water absorption, lb per sq ft	0.108	0.108	0.028	0.016	0.030	0.031	0.027
Compression set, percent	3.0	0.8	1.9	1.9	1.9	1.7	2.8
Volume loss on heat aging, percent	5.0	1.0	1.0	0.4	0.8	0.03	0.9
Flame duration, sec		15	21	31	15	0	0
Length of char, in.	*	*	*	*	*	2.75	2.5
Oil resistance	No softening	No softening	No softening	No softening	No softening	No softening	No softening
Tensile strength, psi	31	76	44	180	126	75	60

* Completely consumed. † Failure at 25 percent deflection. ‡ Failure at 10 percent deflection.

Table VI—Properties of Cellular Cellulose Acetate

Property	Strux CH 145	Strux CH 156	Strux CH 167	Strux CH 178
Ultimate compressive strength, psi	131	100	117	237
Density, lb per cu ft	5.2	5.5	6.7	7.7
Water absorption, lb per sq ft	0.10	0.145	0.098	0.059
Compression set, percent	2.0	0.5	0.1	1.0
Volume loss on heat-aging, percent	1.0	0.7	0.7	
Flame resistance	None	None	None	None
Oil resistance	No softening or swelling	No softening or swelling	No softening or swelling	No softening or swelling
Tensile strength, psi	225	75	73	247

rials with high absorption properties.

Test values of sound absorption coefficients, measured at 512 cps using the open hollow tube method, are given in Table III for several materials. The test results are quite variable. One sample of unicellular soft polyvinyl chloride gave a high value, while a sample of unicellular hard Styrofoam gave a comparatively low value. The phenolic foams having a large percentage of open cell construction exhibited variously high and low values.

The spread of the sound absorption coefficients of the expanded polyvinyl chloride material referred to in Table III as No. 1 is shown in Fig. 1 (A). The coefficient is high between 500 and 600 cps. In Fig. 1 (B) is shown the spread obtained with another expanded polyvinyl chloride material, which in Table III is referred to as No. 3; here a peak value occurs at 700 cps. At 512 cps, the value of the coefficient is low.

Molded and Extruded Foams

EXPANDED POLYVINYL CHLORIDE materials are characterized by a high degree of unicellularity. The process employed in their production is essentially high pressure molding. To permit easy opening of the mold and removal of the molded piece, a rapid cooling cycle is required to relieve pressure in the mold. The pieces are first molded to about one-half the size desired, then in a following heating operation are expanded to full size. This subsequent growth is subject to fairly good control.

The outstanding properties of expanded polyvinyl chloride materials are low density, low water absorption, good flame or fire resistance, resistance to weathering, and oil resistance. In Table IV are given the range of properties of expanded polyvinyl chloride materials of different degrees of hardness or compression resistance.

Polyvinyl chloride foamed plastics have been molded in tubular pieces as large as 13 in. O.D. by 6 in. I.D. by 9 ft. long, and in flat sheets 36 in. square in thicknesses up to 3 in. Sheets 50 by 84 by 1 in. are currently produced.

In flat sheet form, the price of polyvinyl chloride foam ranges from $1.00 to $4.60 per lb. A soft flexible sheet $\frac{5}{16}$ in. thick with a skin on one side is currently selling for about 33 cents per square foot.

EXPANDED POLYSTYRENE is produced by an extrusion process in which the heated resin, with a large volume of gas dissolved in it, is released through an orifice. The gasified resin upon reaching atmospheric pressure expands considerably to a cellular plastic structure. Expansion of the gas in the process assists in cooling the resin during solidification.

This material, known as "Styrofoam," is marketed by the Dow Chemical Company in the forms of finished boards, rough planks, and rough logs. Finished boards range in price from 16 to 18 cents per board foot, or about 94 cents per lb. In truck or carload quantities, the price of rough planks and rough logs ranges from 55 to 60 cents per pound.

In examining the data pertaining to Styrofoam given in Table V, the commercial grade is seen to possess

many desirable properties. With the exception of the two higher density fire retardant samples, all the Styrofoam samples tested burned rather completely. The Dow Chemical Company has currently on the market a Styrofoam that is fire retardant and represents a considerable improvement over the non-fire retardant grade in this respect. Styrofoam is attacked by most of the organic solvents.

The Bureau of Ships has made use of Styrofoam in a process for producing LCVP craft utilizing polyester resin and fibrous glass combinations. The Styrofoam provides a mold over which the glass cloth is placed and that provides a web separation between the laminates that form the structure of the boat hull.

CELLULAR CELLULOSE ACETATE is cellulose acetate expanded into a foam material with a gas during a high pressure extrusion process. This material was developed by the duPont Corporation; under the trade name "Strux," it is produced by the Aircraft Specialties Company in ½ by 8 in., ¾ by 4 in., and 1 by 4 in. sizes in lengths up to 10 ft. Longer lengths, however, can be produced. Cost is about $1.00 per pound.

The physical properties of cellular cellulose acetate are given in Table VI. The Strux designations refer to the density of the grade; that is, CH145 refers to a product having a density between 4 and 5 lb per cu ft, CH167 refers to density between 6 and 7 lb per cu ft, and so on. The commercial grade has a density between 5 and 6 pounds per cubic foot.

Cellular cellulose acetate has rather outstanding ultimate compressive strength when compared with that of other cellular plastics. Water absorption is low, but not as low as that of the cellular vinyls. The foam cell construction is fine and unicellular. This material has good heat resistance and its volume loss is small after heat aging a week at 140 F. It is resistant to permanent set under light loadings. When once ignited, this material is completely consumed.

In sandwich constructions, cellular cellulose acetate materials provide more stiffness and strength than do most other cellular plastics. This statement is based essentially on the high compressive strength of the material.

EXPANDED BUTADIENE-STYRENE-ACRYLONITRILE. This material is chemically expanded by the thermal decomposition of a nitrogen producing rubber blowing agent. The process is essentially one of low pressure, thus permitting the use of simple and comparatively inexpensive molds. Fairly large pieces can be produced. This foam material is obtainable in molded shapes and in flat sheets 46 by 70 in. in size in ¼, ½, ¾, and 1 in. thickness. Costs in end items range from $2.00 upward per pound.

The properties of expanded butadiene-styrene-acrylonitrile, which is known by the trade name "Expanded Royalite," are given in Table VII. This cellular product has very low water absorption, reasonably good compressive strength, and good heat resistance as evidenced by low volume loss after a week at 140 F. This material can be produced in densities ranging from about 5 to 15 lb per cu ft. It can be compounded to have good resistance to burning, but with some sacrifice in physical strength.

Expanded Royalite is being applied for padding on instrument panels, liners for crash helmets, and pads for body protection.

Table VII—Properties of Expanded Butadiene—Styrene—Acrylonitrile

Property	Specimen					
	A	B	C	D	E	F
Ultimate compressive strength, psi	18	77	58(25%)	19(25%)	30	14
Density, lb per cu ft	6.2	7.9	5.4	6.1	7	4.2
Water absorption, lb per sq ft	0.10	0.003	0.04	0.08	0.044	0.046
Compression set, percent	7	3	0	22	14	50
Volume loss on heat-aging, percent	2	1	0	−1	−0.1	−0.1
Flame duration, sec	19	40	5	0	12	10
Length of char, in.	Consumed	6	6	1	5	5
Oil resistance	No softening or swelling	No softening or swelling	No softening or swelling	No softening or swelling	No softening or swelling	Distorted only
Tensile strength, psi	257	198	118	140	210	81

Table VIII—Properties of Foamed-in-Place Phenolic Foam

Designation		Water absorption and Buoyancy values given are after 24 hours of immersion under 30 ft of water.				
		Density, lb per cu ft	Ult. compressive strength, psi	Buoyancy, salt water, lb per cu ft (calculated)	Water absorption, lb per cu ft	ph
General Electric	S–1028	1.2	6.4	31	31.8	
	12313D	1.9		33	29.1	
	12313G	2.6		28	33.4	
	12313E	8.8	50	20	35.2	4.5
Bakelite	Z	6.4	40	21	36.6	3.0
	Y	8.4	90	18	37.6	
	X	10.0	115	19	35.0	
	1	0.6	3	crushed		
	2	1.2	7	crushed		
	3	1.8	16	14	48.2	
	4	2.5	37	18	43.5	
	5	2.9	41	16	45.1	
	6	5.0	52	21	38.0	
	A	2.0	13	22	40.0	2.5
	B	1.9	10	37	25.1	2.7
	C	2.5	15	20	41.5	2.4
	D	2.6	15	36	25.4	2.9
Westinghouse "Insulfoam B"	(A)	2.1	12	30	31.9	
	(A)	2.5	12	25	36.5	
	(C)	5.2	57	20	38.8	
	(D)	6.8	19	24	33.2	
	(E)	8.6	111	20	35.4	
	(F)	4.0	22	28	32.0	

Foamed-in-Place Resins

PHENOLIC FOAMED-IN-PLACE RESINS are essentially fresh phenol-formaldehyde reaction products that at the time

of use are reacted with phenol-sulfonic acid. Considerable steam is evolved in this reaction. The resin upon cooling solidifies into a low density cellular somewhat buoyant material. The outstanding advantage of the foaming-in-place operation is that the liquid is transformed into a cellular product without the external application of heat.

The handling techniques of these phenolic foams are quite similar. After the acid catalyst has been stirred into the resin, the reaction and foaming start and the material must either be poured where it is wanted or be permitted to foam where it is. The foaming becomes extremely active within about five minutes after the acid or catalyst is added. During foaming, considerable steam and formaldehyde vapor is formed.

An examination of the data given in Table VIII indicates that foamed-in-place phenolic foams generally have low densities (1 to 8 lb per cu ft) and the compressive strengths of these materials are fairly low. Buoyancy properties are only fair when tested under a 10 to 30 ft head of water. (See *Journal of American Society of Naval Engineers,* Vol. 62 No. 1, Feb. 19, 1950; p 139–144. Stark, Alpert, Shoemaker).

The buoyancy after immersion for various time periods under a 30 ft head of water of three phenolic foams of different densities are compared in Fig. 2 with those of balsa wood and cellular hard rubber. The buoyancy of 1.9 lb per cu ft density phenolic foam is more than that of the best grade balsa wood and the higher density phenolic foams. Cellular hard rubber is outstanding in buoyancy.

The residual acidic characteristics of the phenolic foams vary. Their ph factor is important where the foam is used to obtain buoyancy and is inclosed in metal containers, since there is a possibility of the foam material coming in contact with water. Under such conditions, accelerated corrosion can be expected. To prevent or retard such corrosion, metal surfaces should be protected with an asphalt type varnish or coating. (See *Journal of American Society of Naval Engineers,* Vol. 64 No. 1, Feb. 1951, p 49–58; Stark, Kaminetsky and Winans).

The ability of these phenolic foams to withstand vibration and shakedown is variable. Insulfoam has exhibited excellent resistance qualities when vibrated at 0.30 in. single amplitude and 30 cps, such as might be encountered in the structure and the hull of a ship.

Although industrial and commercial applications for phenolic foam have to date been quite limited, their use in packaging is being developed and appears to have some advantages.

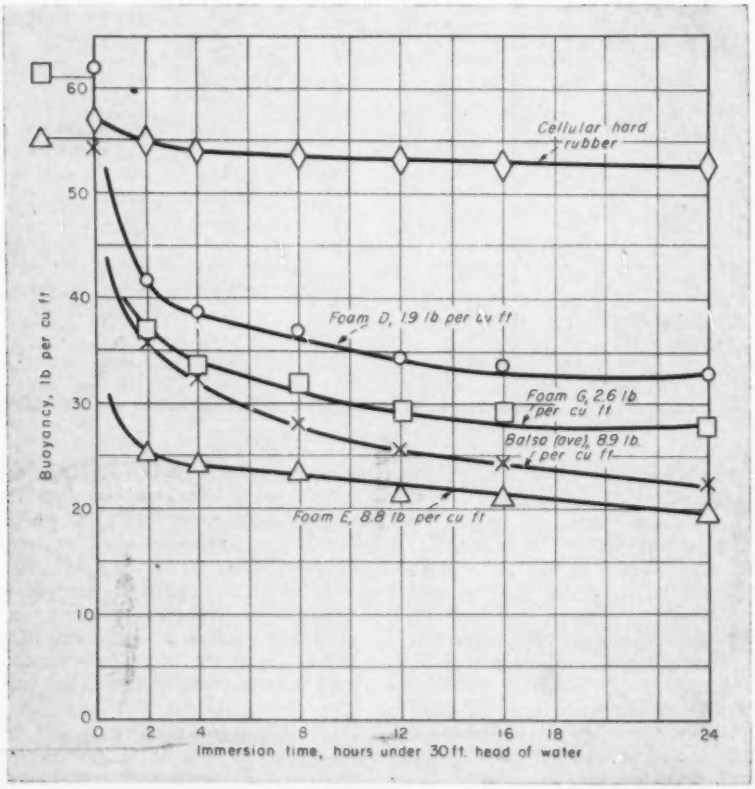


Fig. 2—Buoyancy after immersion under a 30 ft head of water of three phenolic foams of different densities compared with that of balsa wood and cellular hard rubber.

POLYESTER FOAMS. Polyester resins can be foamed in place at room temperature without the application of heat. They have not been produced, however, in very low densities nor are they unicellular. Densities of 3 to 4 lb per cu ft are about the minimum. Also, physical strengths are quite low.

Polyester foams are produced by either of two methods: Mechanical; and chemical.

In the mechanical method, a gas such as freon, propane, or methane is dissolved in the resin under pressure and continuous stirring. After a catalyst is added under pressure and stirring, a room temperature cure promoting agent is added. After an accurately measured time of stirring, the foam or froth is released through a nozzle. The foamed polyester thus formed starts to gell immediately with little collapse and then cures hard in about 10 minutes.

The chemical method consists of preparing a carefully balanced mixture of resin, catalyst, room temperature cure promoter, maleic anhydride and ammonium bicarbonate. A small amount of water is then added to trigger the reaction between the maleic acid and the ammonium bicarbonate. Carbon dioxide is liberated and expands the resin. The cure starts when the maximum expansion of the resin is reached, and the foam sets in about ten minutes after it is cured.

Some of the major hindrances in working with polyester foam are: Difficulty in producing low densities; obtaining stability in the foamed liquid uncured resin; and coordinating the gell and cure with the time of maximum expansion.

Mixtures of epoxy-type compounds and polyester resins expanded with "celogen" and heat have produced foams of 2 lb and less per cu ft density. These foams, however, are not unicellular.

Polyester foams are still experimental; they may provide another foaming-in-place resin for large void space filling applications.

Editor's Note:—For more information on properties and applications on foam plastic materials, see "Foam Plastics as Engineering Materials," *Product Engineering,* April 1952, pages 192 to 198.

Designing Around Inert-Gas Metal Arc Welded

• *Stainless* • *Nickel and Stainless Clads*

• *Copper*

• *Copper Base Alloys*

• *Aluminum*

Fig. 1—Welding stainless steel with the Aircomatic process offers the versatility of a manual operation with the production advantages of semi-automatic operation. No flux or slag removal is required.

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ORIGINALLY DEVELOPED for joining thick sections of structural aluminum, the inert-gas metal arc, or Aircomatic process is now being applied to other hard-to-weld materials. These include stainless steels, nickel and stainless clads, copper and copper base alloys, usually in thickness of ¼ in. or more. The result is a stimulant to the use of these materials, which are costly as well as difficult to fabricate with the older processes.

Important characteristics are:

(1) Versatility of a manual operation with the essential features of semi-automatic welding.

(2) Adaptable to fully automatic production.

(3) Minimum joint edge preparation.

(4) Ability to control penetration.

(5) Elimination of fluxes and slag removal.

(6) Continuous deposition of filler metal at high rates.

(7) Ability to weld heavy sections with little or no preheat.

(8) Visible arc, no blind welding.

In addition, when used with a fully automatic head, other unique advantages can be obtained. By using the stringer-bead technique a welder can maintain high deposition rates and, at the same time, control the energy input per inch of weld. This makes it possible to select the best technique for a given job. The joint can be made either of several small beads or one large one, which provides flexibility in controlling weld metal cooling and heat absorption in the base metal. Since the deposition rate is independent of welding speed, good joints

at competitively high speeds are possible even with materials that have been difficult to weld.

STAINLESS STEELS

All commercial austenitic stainless steels can be fabricated with equal ease. One reason is that the alloying elements in the wire are efficiently transferred. Even the titanium used to stabilize some grades of stainless transfers with about 60 percent efficiency, as compared with practically no transfer in a conventional electrode arc. Secondly, the freedom from slag and flux, eliminates interpass cleaning and assures that the weld will be free of inclusions which may weaken either its strength or corrosion resistance.

In general, welding costs can be reduced wherever stainless is welded in heavier than sheet thicknesses. Current fields of application include chemical process equipment, petroleum refining equipment, high temperature materials, sanitary and food-processing units, special transportation, and structural assemblies. Also, stainless steel can be overlaid on valves, bearings and seats. Overlays on mild steel castings or forgings are common. One job, Fig. 2, involves the welding of three circumferential bands of stainless on a steel casting larger than 30 inches in diameter. This provides all the corrosion resistance required at a cost considerably less than that of a solid stainless casting.

In automatic operations, electrode wire deposition can be combined with auxiliary filler wire feed to affect the high deposition rates which are so important in overlay work. For example, when an operator uses a single wire current carrying electrode $\frac{1}{16}$ inch in diameter, the deposition rate operating at 325 amp is approximately 10 pounds of stainless per arc hour. Using the same current with an auxiliary cold wire 0.045 inch in diameter the rate can be increased to 17 pounds per arc hour. Further increases are possible with larger diameter electrodes and higher currents.

CLAD METALS

The important characteristics as far as this group of materials is concerned are that the size and feed speed of the filler wire can be varied, as well as the electrode size and welding current. This gives more flexibility to the relationship between current input and the amount of metal being deposited. Also, penetration, dilution of weld deposit by base metal, and deposit rate can be controlled to suit the job.

On both stainless and nickel clads, superior results are claimed in terms of service, appearance and lower production costs. Welds on the clad side have substantially the same corrosion resistance as the cladding. This allows manufacturers to use clad steels which are cheaper than comparable solid stock for such products as heat exchangers, condensers, and evaporators.

Another stimulant to these applications is the time saved in cleaning welds between passes as compared to conventional methods. One company, now using the process to fabricate nickel-clad evaporators, is welding 20 percent nickel-clad ranging in thickness from $\frac{1}{4}$ inch to $\frac{3}{4}$ inch. Commercially pure nickel electrode wire $\frac{1}{16}$ inch in diameter is deposited under a blanket of argon shielding gas. Many interior parts of solid nickel can be welded in the same manner.

COPPER

Copper is one of the perennial headaches of the welding industry. Its high conductivity makes the input of heat a serious problem; flux is required to permit quality joints by the oxyacetylene and other older methods.

These problems are overcome by the inert-gas metal arc process. With the gun and automatic head, several manufacturers are welding deoxidized copper 1 in. or more in thickness with marked success. Another company is fabricating large acetate mixing vessels made of $1\frac{1}{8}$ in. thick copper with a manual gun at a wire feed speed of 396 in. per minute. Deoxidized copper wire $\frac{1}{16}$ in. in diameter is used. The vessels are six feet ID and about three feet deep. A mixture of approximately 80 percent helium and 20 percent argon is used for shielding gas. Gas flow is 50 cubic feet per hour of helium and 10 cubic feet per hour of argon. The joint for the girth weld on the cylinder is a single Vee with a 90 deg included angle, as shown in Fig. 3. An opening of $\frac{3}{32}$ in. insures complete penetration. The welds are made in four passes on one side; the other side is back chipped and welded in one pass. A preheat of 300 deg gives best results. The operator perference on this job was a back-hand technique.

As another example, the girth weld in $\frac{5}{8}$ in. copper tanks is made in a single pass at high speed by rotating the tank in front of a manual welding station. In still other cases, material $\frac{1}{2}$ in. to 1 in. thick with either butt or fillet welds are made with comparative ease with the automatic head.

COPPER BASE ALLOYS

Several industrial copper-base alloys are even more readily applied than copper itself. These include aluminum bronze, silicon bronze, phosphor-tin-bronze, and leaded phos-tin-bronze.

Aluminum bronze is important as a tough, wear-resistant but resilient coating on casting and sealing surfaces in heavy chemical equipment, dies, and other apparatus. Satisfactory de-

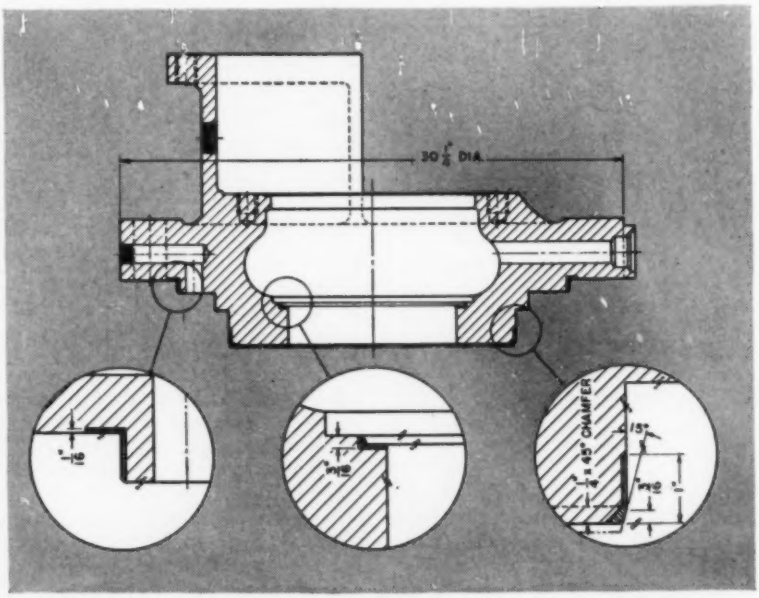


Fig. 2—Three stainless steel overlays are laid on critical areas of this mild steel casting to provide corrosion resistance without the expense of using an all stainless part.

posits of this type now can be made on steel, cast iron, and the tin-base bronzes, without difficulty.

Aircomatic welds on aluminum bronze have been approved under the ASME boiler code. They also offer a means of fabricating these plates to replace cast parts for other applications.

With silicon bronze marked success has been obtained, particularly when relatively thick sections are involved. The softer bronzes—phos-tin-lead for example, which is often used for railroad bearings—can be manufactured or rebuilt, as can steel mill guides, which require frequent build-up.

ALUMINUM

With aluminum, the principle attractions are the high deposition rate and ability to weld without flux. Cleaning and inclusions can present serious problems when a flux is needed. Although the inert-gas-shielded tungsten (non-consumable) arc process eliminates flux, the speeds are not comparable to those possible with Aircomatic and their effectiveness is with thin section, usually $\frac{1}{8}$ inch and smaller.

All of the weldable aluminum alloys and the wrought materials 2S, 3S, 4S, 52S and 61S are equally applicable. Although light gage stock can be welded, the process is recommended primarily for thicknesses of $\frac{1}{4}$ inch or more. Typical applications are in shipbuilding for hulls and superstructures—fabricating structural frames and bodies of trucks, trailers and buses—in railroad shops for repairs on diesel engine pistons—in the field of petroleum and chemical storage and process equipment.

One company has recently constructed several fatty acid storage tanks as part of a general replacement and expansion program. These tanks, 20 feet in diameter, are made of 2S aluminum plate, $\frac{3}{8}$ inch thick. Each one is 21 feet high and has a storage capacity of approximately 50,000 gallons. About 1,000 feet of linear weld was required for each tank. Using Aircomatic, less than one ounce of filler metal was consumed per foot, and only 50 to 60 pounds of filler wire was required to do all the welding on the tank, an estimated saving of 75 percent over the previously-used method.

Most of the joints in this job were square butt with no edge preparation necessary. Fabrication time in the field with one welder and a helper was approximately 200 hours per tank or about half the labor needed for older processes. A manual gun was used with $\frac{1}{16}$ inch diameter 2S electrode wire.

Results such as the above are stimulating the use of aluminum by putting its fabrication on a competitive footing; it enables users to enjoy added protective insurance against discoloration, loss of stability, and many other acid-corrupting influences that are traceable to corrosion in older types of tankage, piping and apparatus.

MILD STEEL

The competition confronting the inert-gas metal arc process in this field is distinctly different from that encountered with hard-to-weld metals. Steel is not hard to weld. It presents no particular difficulties for the older process. Techniques and procedures have been developed for conventional processes to the point where it is difficult for a new process to gain a foothold here on a cost, if not a quality, basis.

Notwithstanding, demands to make its speed of deposition and quality welds available in this large market have led to laboratory tests and field applications which indicate the process will, in time, overcome most of the cost and mechanical problems which confront it at present.

An example of the production application of the inert-gas metal arc process to steel is the welding of 22 gage mild steel pipe to a quarter inch thick flange for "cross-over" pipes on exhaust manifolds. Fig. 4 shows a close-up of the weld. A semi-automatic setup at two welding stations produces 1,500 cross-over pipes a day.

When the use of this process on steel becomes established it is not likely to be on the basis of initial cost but rather because of the following features: (1) increased welding duty cycle available; (2) elimination of slag removal; (3) reduced plate-edge preparation; and (4) elimination of electrode stub loss.

Fig. 3—Copper plates 1¼ in. thick ready to be fabricated into a large mixing vessel. Space between plates is for better penetration.

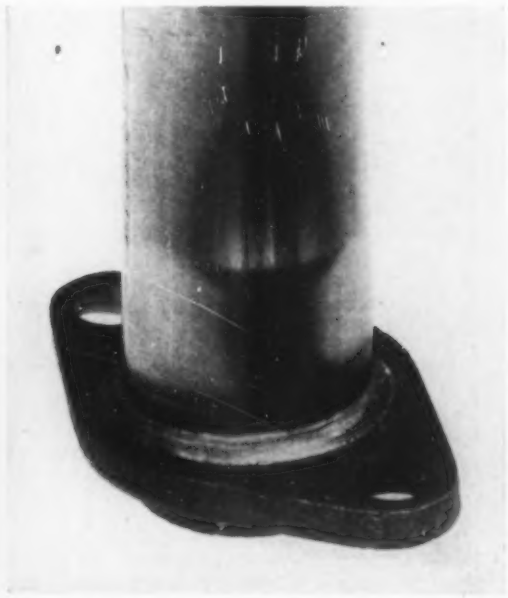


Fig. 4—Close-up of smooth bead deposited in the welding of 22 gage mild steel pipe to a ¼ in. thick steel flange.

Design Tips for Changing

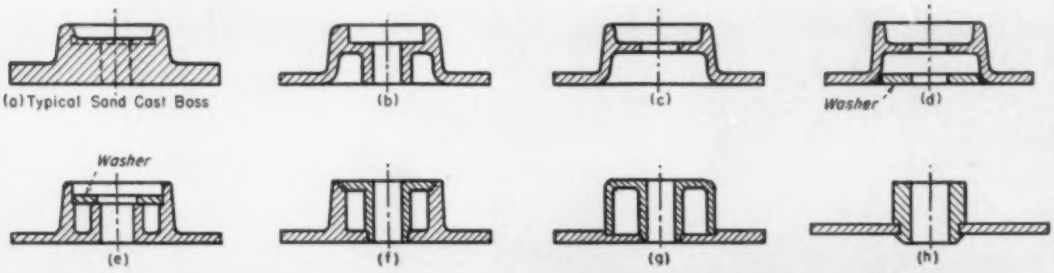
Following the design of the original part too closely can defeat the purpose of the change-over. Based on years of experience, the author shows how specific details should be modified to meet good die casting practice.

WHEN A DESIGNER KNOWS that the part he is developing will be die cast, he usually has enough freedom in selecting material, shape, and other details to assure taking advantage of the desirable features inherent to the process. Should questions arise regarding recommended design practices, he can readily find published data on nearly any phase of the problem. For example, see Product Engineering: "Designing for Die Casting," October 1948, pp 86-91; "Economical Die Casting," August 1949, pp 104-108; and "Establishing Tolerances for Die Castings," April 1951, pp 118-128, 169 and 171 for typical articles.

In practice, however, only a small percentage of all die castings are designed specifically for the process. Most of them are originally intended for other methods of production and, later converted to improve part quality, lower production costs, or both. These conversions nearly always require more thought and effort than original designs since there is a tendency to make the die casting an exact copy of the original. This rarely can be done without losing many or all of the benefits that actually stimulated the change-over.

An exception is when the conversion is foreseen, and sand casting or some other method of production is used until the demand for the product is adequate to warrant the investment in dies. In such cases, the requirements for effective die casting can be built into the product at its conception. In general, however, the safest method of insuring satisfactory results is to disregard completely the existing shape of the part, the materials and methods used, and the type of finishing operations that are specified. Three factors must be established—completely free from prejudices of the prototype—(1) mechanical function of the part, (2) nature and range of stresses that will be active in service, and (3) allowable space within the complete assembly for mounting purposes.

Of course, mating parts or other assembly requirements may limit variations of such details as bosses, flanges and ribs. In many such cases, minor modifications can be made which will govern the success or failure of the conversion—still within the limits of the initial requirements. The sketches



DESIGN OF BOSSES. Design (b) avoids thick sections like (a) which tend toward porosity by using an annular core. Within limits, size of hole and counterbore can be varied by using interchangeable cores. When loads are light and bolt alignment is not critical, (c) is recommended. The thin web can be machined for holes other than the as-cast size. In (d), a press-fit washer (stamped or die cast) improves bolt alignment. When the bolt height is variable, bosses should be lightened from the top face, as provided by (e). In large castings with different size holes, interchangeable inserts (f) are often preferable to (b). When bosses of varying height and diameter are required, the whole boss can be a separate casting as in (g). This is preferred to casting and machining a solid boss. Projections on flat, thin sections should also be avoided. A separate boss, riveted or soldered, (h) is better.

to Die Casting

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on the following pages illustrate how basic design features of this type, developed originally for some other method of production, should be adapted for die casting.

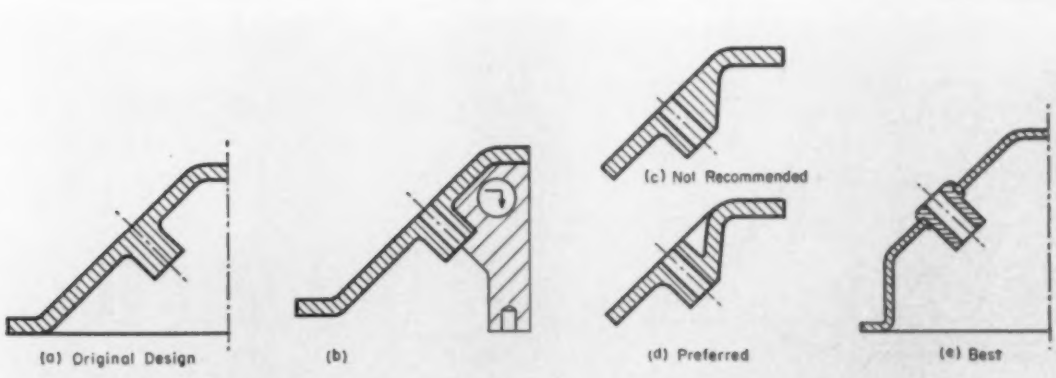
As far as materials are concerned, the overall pattern of converting is generally definable. Heavy-section sand castings originally made of iron and, to a lesser extent, brass are replaced by zinc-base die castings; some brass sand castings and small hot-forgings become brass die castings; aluminum die castings replace aluminum sand castings and thin-section iron sand castings, extrusions and fabricated sheet metal assemblies; magnesium die castings replace plastic moldings, thin-sheet stampings and parts previously die cast in aluminum alloys.

Exceptions to this pattern of materials substitution are unusual—and should be analyzed critically if they are specified.

Table I—Approximate Dimensional Limits for Die Castings in Various Alloys

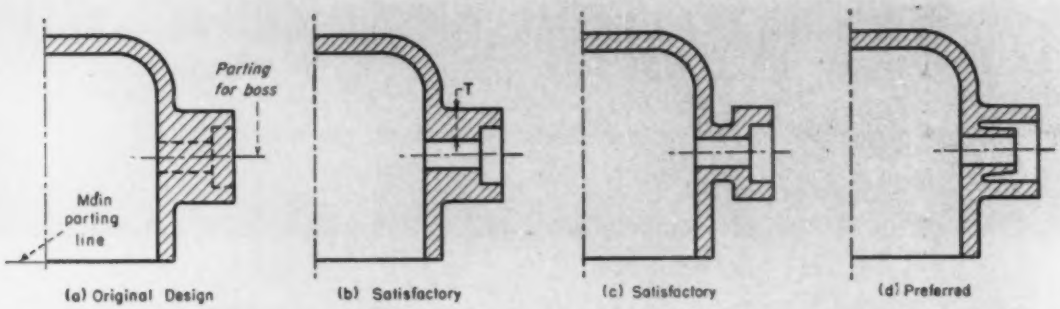
	Zinc Alloy	Aluminum Alloy and Magnesium Alloy	Copper Alloy (brass)
Minimum wall thickness, large castings, in.	1/16	0.085	1/8
Minimum wall thickness, small castings, in.	0.030	0.050 (1)	0.050
Tolerances within solid die, in., (2)	0.001 per in. but 0.0025 min.	0.0015 per in. but 0.003 min.	0.003 per in. but 0.005 min.
Cast threads external, max number per in.	24	20 (1)	10
Cast threads internal, max number per in.	24 (3)	8 (1)	None
Cored holes, min dia, in.	0.030	3/32	3/16
Minimum draft per in. of length or dia of cores, in.	0.003	0.015	0.020
Minimum draft per in. of length or dia at side walls, in.	0.005	0.010	0.020

(1)—Small aluminum die castings having walls only 0.040 in. thick have been produced in quantities, as have been also some threads as fine as 24 per. in.
(2)—Applies only to dimensions between points formed by solid portions of die. When dimension is across parting or between points controlled by parts of die having relative motion, wider limits must be allowed.
(3)—If cheaper than tapping. Fine internal threads are nearly always tapped.

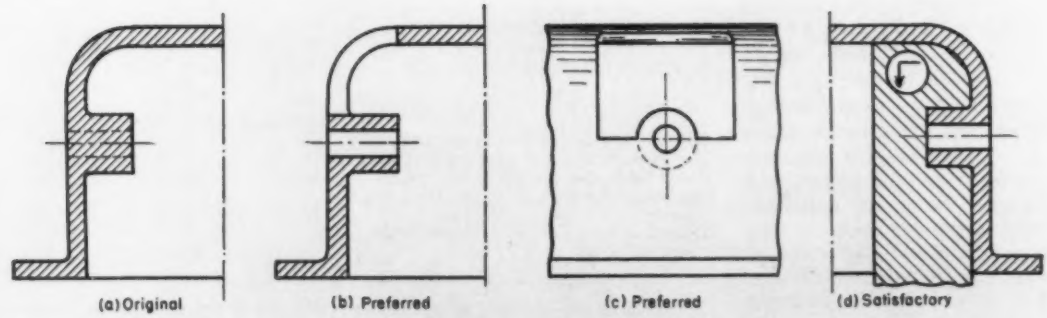


INCLINED, INTERNAL BOSSES. Common sand casting practice, (a), is undesirable for die casting not only when, uncored but even when cored, (b), collapsible type cores are required to keep section thicknesses uniform. This is a slow process since the cores must be removed by hand after the die casting is ejected. Conversion (c) is not generally recommended because of the thick section above the cored hole; (d) is preferred if the recess can be tolerated. For thin sections, 1/16 in. or less, it is usually best to insert a separate bushing (e) in a punched-hole.

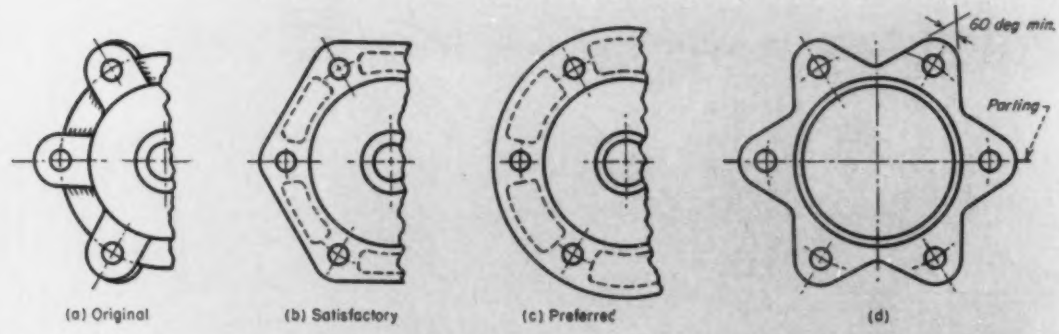
(Continued on next page)



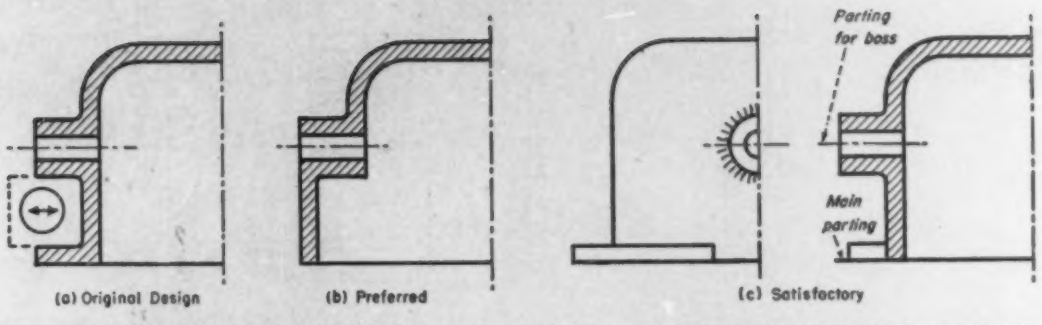
CORED LATERAL BOSSES. Details like (a) should be avoided since they involve a stepped parting line in the die and difficult-to-feed heavy sections. Coring as in (b) reduces section thicknesses and is satisfactory, if *T* is not more than twice the main casting wall thickness. If so, the original can be modified as in (c). In general, however, annular cores (d) are preferred. These are particularly useful when several different hole sizes are to be used.



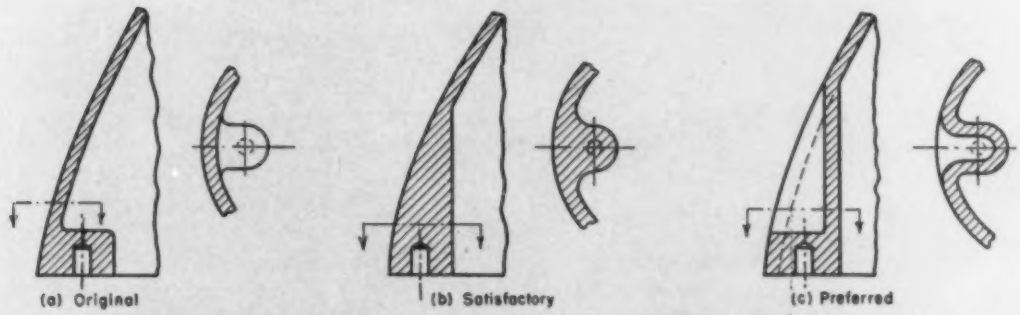
INTERNAL, LATERAL BOSSES. The objections to (a) are the same as those mentioned on pg 175; for die casting (b) is preferred. Here, the bottom of the boss is formed by one half of the die and the top by the other. This necessitates a relatively large opening in the casting, see (c). This can be an advantage to give access to internal parts. If it is objectionable, collapsible core (d) can be used to form the undercut—but this is expensive at best.



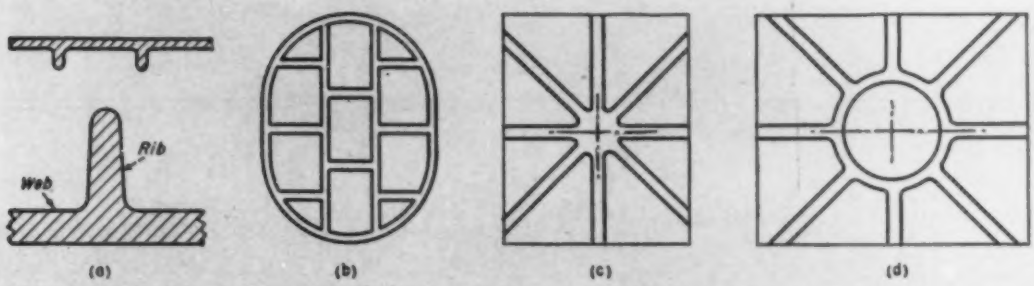
BASE PLATE DESIGN. Equally spaced lugs of (a) are difficult to die cast because of undercuts and undesirable as far as flash removal is concerned. Six-sided base with rounded corners (b) eliminates undercutting. Areas between bolt holes are recessed to save metal and make sections more uniform; (c) is better than (b) since only a circular trimming tool is needed. The flange is also stronger and lighter than either of the previous models. When a component is cast with the cavity split symmetrically between the two halves of the die, the lugs can be designed with an included angle of 60 degrees or more, as in (d), to eliminate undercutting.



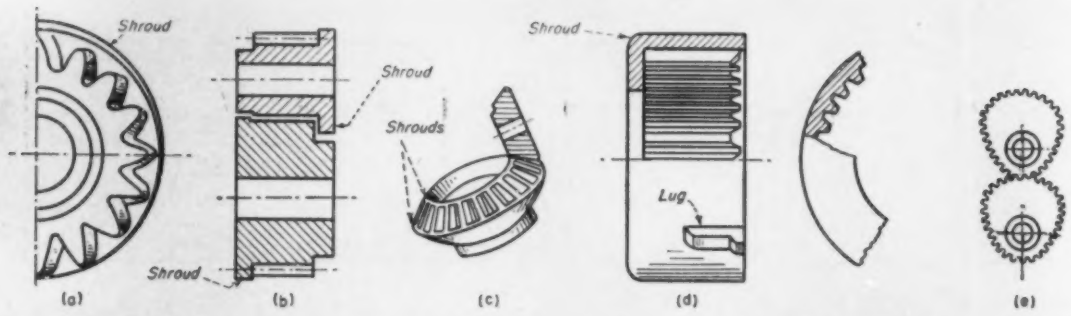
LATERAL BOSSES ABOVE A FLANGE. To die cast the original design (a) would require complicated dies with lateral elements; the cost would generally be prohibitive. Modification (b) is preferred if the change in wall location is acceptable. If not, a section of the flange wider than the boss should be eliminated (c). The parting line then can be stepped—which is justified in this case, particularly if the boss is to have cast threads.



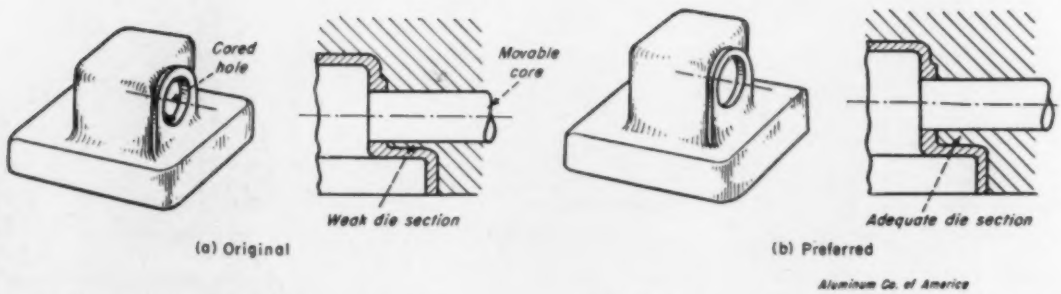
TAPPED BASE LUGS. Original design (a) is undesirable because it is undercut and requires the die to have moving elements; (b) is satisfactory since it has no undercuts but it does have a heavy section which can be troublesome and requires more material. Making the hole deeper than required for tapping will help but the preferred method is shown in (c) since it eliminates both problems completely and conforms to good design practice.



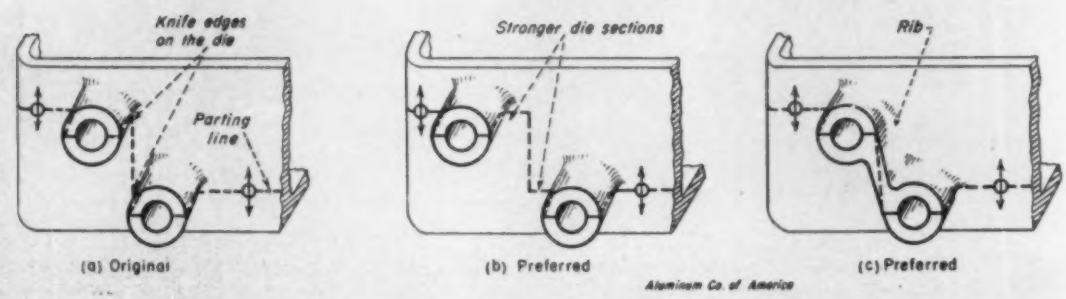
STRENGTHENING RIBS. When added to improve strength-to-weight ratio of the original design, ribs, should have rounded ends and fillets as in (a). Optimum fillet radius is net thickness plus rib thickness divided by three. Ribs should not be thicker than web. When ribs are used in two directions (b), their points of intersection should be staggered. This detracts little from the stiffening effect and improves the metal flow. Multiple intersections like (c) are undesirable since they are conducive to casting imperfections and die overheating. Good alternative is shown in (d). Circular wall should be designed so that space between ribs is two or three times their thickness.



DIE CAST GEARS. Die cast gears should be shrouded, (a), if possible. If this is not done, the flash trimming tool must also be of gear-form. Shrouding should also be on opposite sides of meshing gears as (b). When a die cast bevel gear meshes with a cut gear (c), both ends can be shrouded as shown. Shrouded internal gear (d) can have thinner walls than a machine cut, unshrouded gear of comparable material. The external lugs shown facilitate assembly. Eccentric and elliptic gears (e) are readily die cast at costs comparable to conventional gears.



CORED HOLE in the original casting (a) is too close to the wall below it. This can result in a weak die section that fails almost immediately in service. Preferred design (b) is developed either from lowering the height of the shoulder or increasing the distance between the top of the shoulder and the center line of the hole.



OFFSET BOSSES. Offset parting line in original part (a) requires a knife edge on each die half. Preferred design (b) spaces bosses farther apart allowing adequate die sections on the parting line. Alternate solution (c) leaves a rib between the two bosses to accomplish the same result and still conform to good die casting practice.

Metal Powder Filters

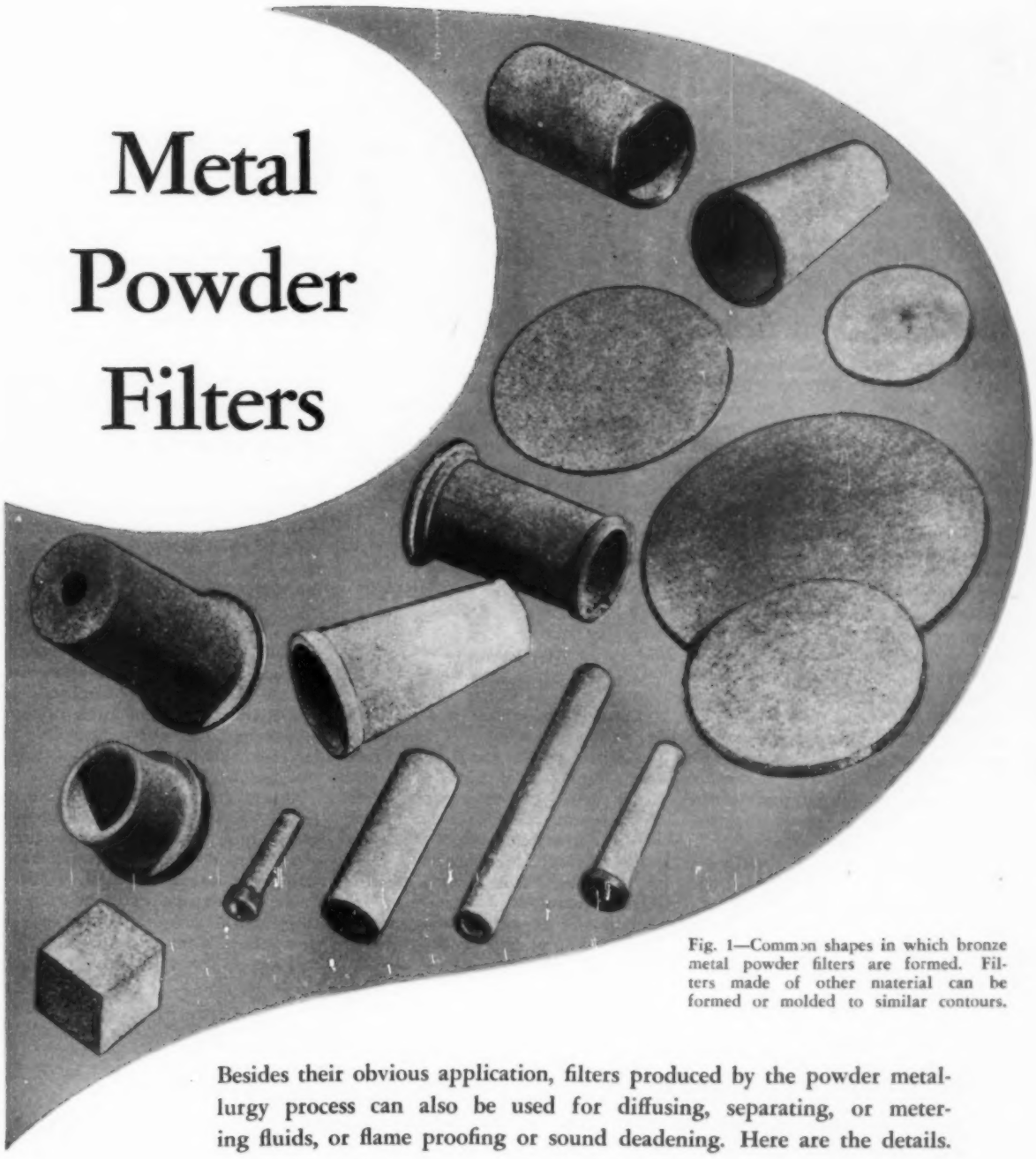


Fig. 1—Common shapes in which bronze metal powder filters are formed. Filters made of other material can be formed or molded to similar contours.

Besides their obvious application, filters produced by the powder metallurgy process can also be used for diffusing, separating, or metering fluids, or flame proofing or sound deadening. Here are the details.

A. J. LANGHAMMER, President
PHILLIP GLICK, Staff Executive
Amplex Mfg. Co.
Subsidiary of Chrysler Corp.

PARALLEL with the rapid advances being made in technology, and with the constant demand for increased performance and higher quality goes the inevitable demand for more and more efficient filters.

Today the functions of filters are manifold. They are employed over a tremendous range of applications.

They must also meet varying specifications. For example, some will be used in the filtering of mediums which are acid in reaction. Others will be used in the handling of mediums basic in reaction; still others with neutral mediums. Some must cope with hot mediums, others with cold. Frequently they must wear or last indefinitely.

Often, filter material is required to do more than merely filter. For example, it may be required to

1. Filter gasoline, air, oil, or other fluids.
2. Diffuse streams of liquids and gases.
3. Separate liquids having different surface tensions.
4. Meter or control the flow of gases and liquids.
5. Act as a flame barrier on equipment used in or near explosive gases.

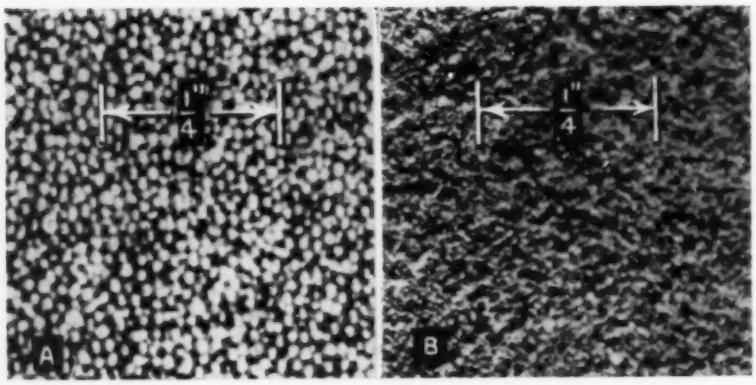


Fig. 2—How bronze (A) and stainless steel powders (B) compare. Grain size of the stainless is much finer, see text. Both powders are of "coarse" grade.

6. Act as a sound damper on equipment with excessive noise level.

To meet these varied requirements, paper, cloth, and other fragile filtering materials are unsatisfactory. Hence the development of the permanent metal-powder filter of the Oilite type. Sturdy and long-lived, such filters are made of stainless steel, copper, iron, nickel-silver, and other metals, as well as of the more familiar bronze.

Unlike ordinary screen filters, metal-powder filters are capable of depth filtration. The fluid being filtered has innumerable paths through which it may move: if deposited particles block direct passage, it is free to flow in other directions until it finds escape openings. It is not confined along one level, nor to one direction.

Porosity, which is of paramount importance, can be accurately controlled from near zero to approximately 50 percent. A coating can be applied to protect the surface of the filter if the nature of the fluid with which it is in contact makes it desirable; tin or nickel plating is usually the answer in these cases, as for example, on gasoline filters where tin is applied to prevent gumming. If even greater resistance to corrosion is required, the filter itself can be fabricated of powder such as stainless steel or nickel-silver.

Metal-Powder for Permanent Filters

Currently, most metal-powder filters are made of bronze. This bronze powder is produced to rigid specifications. While the filter material is normally prepared in three grades—fine, medium, and coarse, Table I—it can be made in other grades to meet special operating conditions.

The particles generally are spherical in shape as shown in Fig. 2. Through a heat-treating or sintering operation they are bonded together to form the shape that is desired.

Because of their low cost and excellent mechanical properties, bronze base metal-powder filters are widely used in the aircraft, chemical, automotive, petroleum, and allied industries, to name but a few.

If corrosion factors are too severe to be met by established grades of bronze, stainless steel filters are usually specified.

As in the case of bronze powders, the stainless steel grains are varied in size to meet different requirements. Pore sizes are much smaller than found in bronze types. They take up in the small pore size range where the other material leaves off. In addition, the unit particle shape is irregular (see Fig. 2).

Filters made of both bronze and stainless steel have high mechanical strength, ductility and shock resistance. They are not friable or brittle, and hence they may be "sized" or installed by a press-fitting operation. In general, it is not necessary to grind or machine filters, but in special instances, these operations are performed on other than "working" surfaces.

Common shapes produced are disks, sheets, plugs and hollow cylinders. One-piece flange type filters, affording increased effective area over plain disk types, are readily made. In cylindrical shapes, fluid flow from the exterior to the interior is recommended to increase filter area and to simplify cleaning.

Other materials previously mentioned—nickel silver, for example—are used for filters when the operating conditions are such that special material properties are required. Because of the rather special nature of many of these applications, it is impossible to detail them in any one article.

Table I shows practical minimum

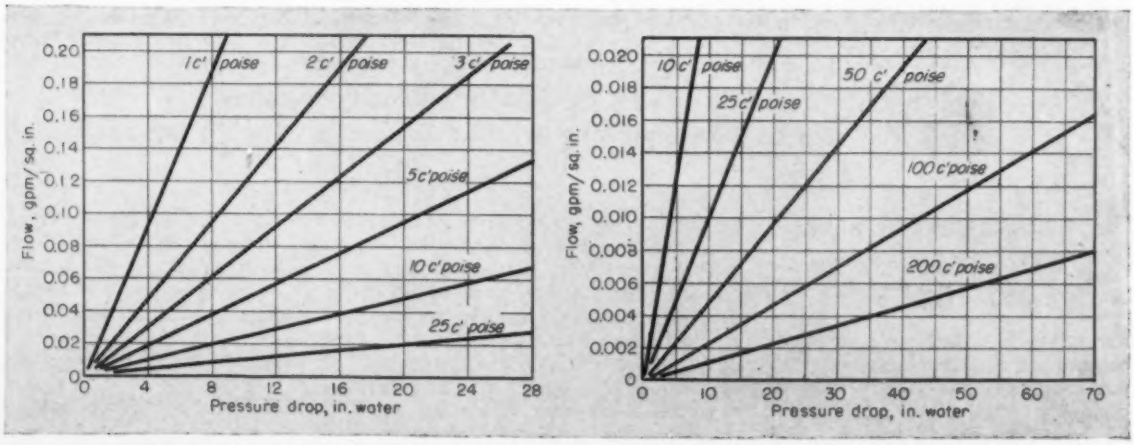


Fig. 3—Pressure drop through fine grain bronze powder filter 1/8 in. thick with liquids of various viscosities. While these values can be used for design calculations, they are approximate only, and should be checked with the manufacturer.

Table I—Grades and Properties of Bronze and Stainless Steel Filters*

Material		Size of Particles Filtered Out, in.	Practical Min. Thickness, in.	Tensile Strength, psi	Elongation, percent	Density lb/cu. in.	Porosity, percent
Type	Grade						
Bronze	Coarse	0.002 to 0.005 & over	0.090	4,000 to 6,000	3	0.165	45–50
	Medium	0.001 to 0.002 & over	0.060				
	Fine	0.0005 to 0.001 & over	0.040				
Stainless Steel	Coarse	0.0004 to 0.0006 & over 10–15 microns	0.060	15,000	2	0.191	20–30
	Fine	0.00016 to 0.00024 & over 4–6 microns	0.060	15,000	2	0.191	10–30

* Based on Oilite filters produced by Amplex Division of Chrysler Corp.

thickness for the bronze and stainless grades. Increasing the thickness, does not materially increase the efficiency of the filter but it does increase its strength and, in some cases, facilitate production.

In the case of bronze, where threads are required for assembling, a threaded element, as of brass or steel, can be bonded to the filter while it is being produced. Bronze filters can be soldered to mounting rings for reinforcement. In the case of stainless steel, threads can be machined.

Sizes run from midgets, several thousand to the pound, to large parts, measured in feet rather than inches. Tolerances, of course vary with size and shape. On disks and sheets, practical manufacturing tolerances are ±0.015 in. on thickness and ±0.015 in. per inch of diameter. On cylinders: ±0.0075 in. per in. of length, diameter, and wall thickness is generally satisfactory.

The foregoing standards are recommended for general guidance considering not only the influence on manufacturing costs, but also the fact that thin sections may not be practical from an operating standpoint. Closer tolerances, of course, may be held by performing subsequent operations but experience shows that generally they are not required.

Data Needed In Designing and Specifying Filters

Requirements for filters can best be met when the manufacturer has full information pertaining to the applications. The following features should be covered adequately in all inquiries.

1. Type of service.
2. Shape of part.
3. Description of assembly. An illustration or sketch is recommended.
4. Type of fluid including viscosity and specific gravity.
5. Size of particles to be removed.
6. Operating temperatures and pressures.
7. Allowable pressure drop.
8. Rate of flow required.
9. Restrictions on filter size, if any.
10. Dimensional tolerances desired. (Submit blueprint if available.)
11. Special features such as flanges, holes, inserts.
12. Number of pieces and schedule of delivery desired.

Curves are available from the manufacturer showing the average pressure drop through various kinds of metal-powder filters, based on the type and viscosity of the fluid. For example, the curves in Fig. 3 illustrates how pressure drop is affected by flow and viscosity for an Oilite bronze filter molded of fine powder.

The curves are based on a filter thickness of $\frac{1}{8}$ in. For other thicknesses, the flow rates and pressure drops would be proportional: a $\frac{1}{16}$ in. thick filter would allow twice as much flow for a given pressure drop, and half as much pressure drop for a given flow rate. A $\frac{1}{4}$ in. thick filter would allow half the flow rate or twice the pressure drop. Other curves, Fig. 4 (*A*) and (*B*), are for air through bronze and stainless steel powder types.

All values are for normally clean

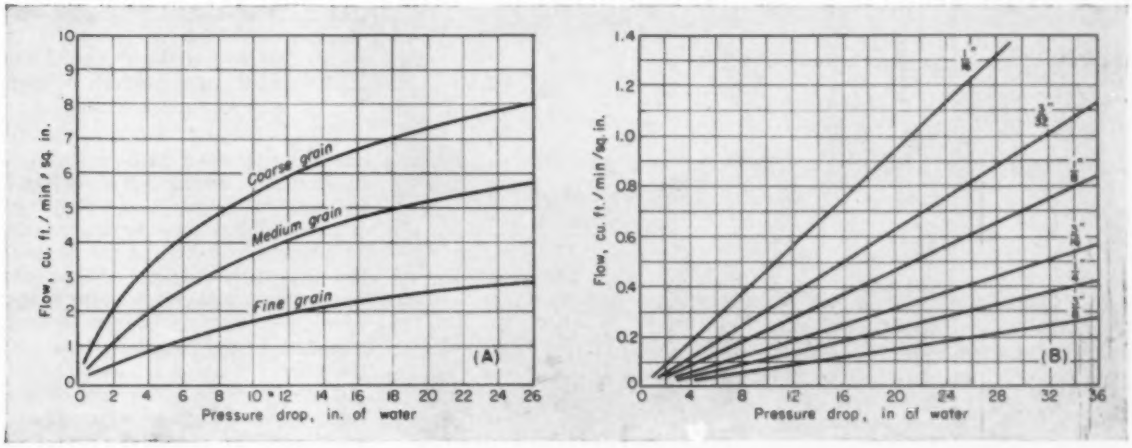


Fig. 4—Air pressure drop through bronze (A) and stainless steel powder metal filters (B) at various flow rates. Curves (A) are based on a filter 1/8 in. thick, while curves (B) are for a coarse grain filter in the thicknesses that are indicated.

filters and are approximate, only. In specific cases, tests may be required to determine flow rates under variable conditions of amount and nature of material to be removed, and frequency of filter cleaning. It is obvious that more filter area will be needed than the theoretical curves indicate. For example, in the Chrysler gasoline tank where the filter is inaccessible for the life of the gasoline tank, it is designed to give 200 times the flow needed during initial operation.

Of course, any effective filter, in removing the foreign matter from the fluid, may eventually become clogged. A simple method of cleaning is "backwashing" by simply reversing the flow of the fluid. High pressure air or steam may be used in reverse flow. Sometimes cleaning is accomplished with a solvent or by burning out the foreign matter with a flame. However, it is frequently more economical to replace smaller elements than it is to clean them.

Typical Applications

As previously indicated, the term filter is used to describe a product with more applications than the name implies and begs a more appropriate name. The range of usage is wide. Following are some typical applications as classified under the use to which the filter can be put:

Filtering. Metal-powder permanent filters can be applied for filtering of all types of fluids ranging from fuel oil and gasoline to corrosive liquids and air. Screening of foreign matter from gasoline at the entrance to the carburetor on aircraft engines to prevent clogging of the carburetor orifices and removal of water or ice particles; straining of fuel oil; and screening of the cooling air for electric motors are typical examples. In this latter case, the filter is used as a vent or breather on the motor to permit the free circulation of air within the housing while excluding particles of dust.

Diffusing. Although not so common as filtering, metal-powder filters are widely used in dehydrators to diffuse air around a drying agent—usually silica gel—for effective moisture removal. Also, diffusing air for aeration of water or liquid is another common application.

Separating. A prominent application of permanent filters is in the gasoline tank of Chrysler cars and trucks, Fig. 5. Its operation is based on the physical law that two immiscible fluids of different surface tensions cannot "take possession" of a surface at the same time. The fluid wetting or taking possession of the surface first will flow through to the exclusion of the other. Water present in the fuel tank either through condensation or other causes, is kept out of the system, preventing the freezing of fuel lines. Of course, dirt also is screened out. A feature of the filter is that it is self-cleaning. Located close to the floor of the gasoline tank, it is continually kept free of foreign particles by the sloshing acting of the fuel in the tank. Thus, the suction tube connected to the unit delivers only clean, filtered fuel.

Metering. A general industrial application is in a compressor air line, between the pressure gages and the main line, where a filter is used to protect instruments from extreme shock resulting from instantaneous change of line pressure. These plugs damp out pulsations and vibrations, thus enabling the gages to record average readings. Further, they keep contaminated oil from reaching the operating parts, thereby functioning both as a metering and filtering element. Also, in the form of a wick $\frac{3}{16}$ in. in dia and $4\frac{3}{4}$ in. long, a filter is used to meter the flow of oil into the air line of a pneumatic tool for controlled lubrication. Its lower end is immersed in lubricating oil and its upper end is extended into the air stream, which picks up a pre-determined amount of oil as the air goes on its way to drive the tool. (See Fig. 6).

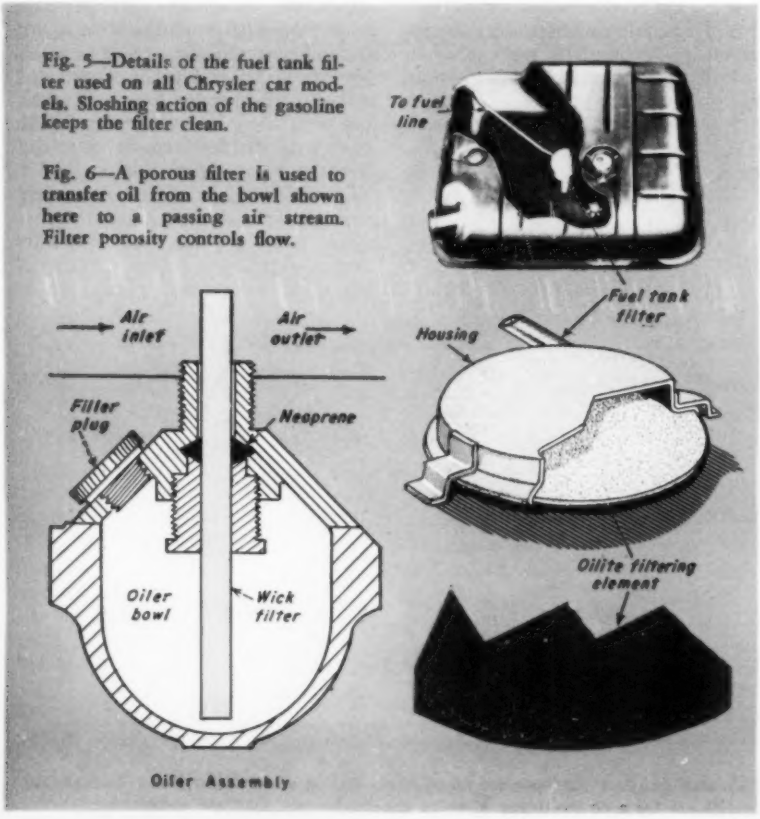
Flame Arresting. In various types of electrical equipment operating in an inflammable atmosphere, filter disks in the housing afford "flame-proofing" or protection against explosion. The mass of the filter absorbs and dissipates the heat of the spark or flame. However, its high permeability allows cooled gases, products of combustion, to pass through harmlessly.

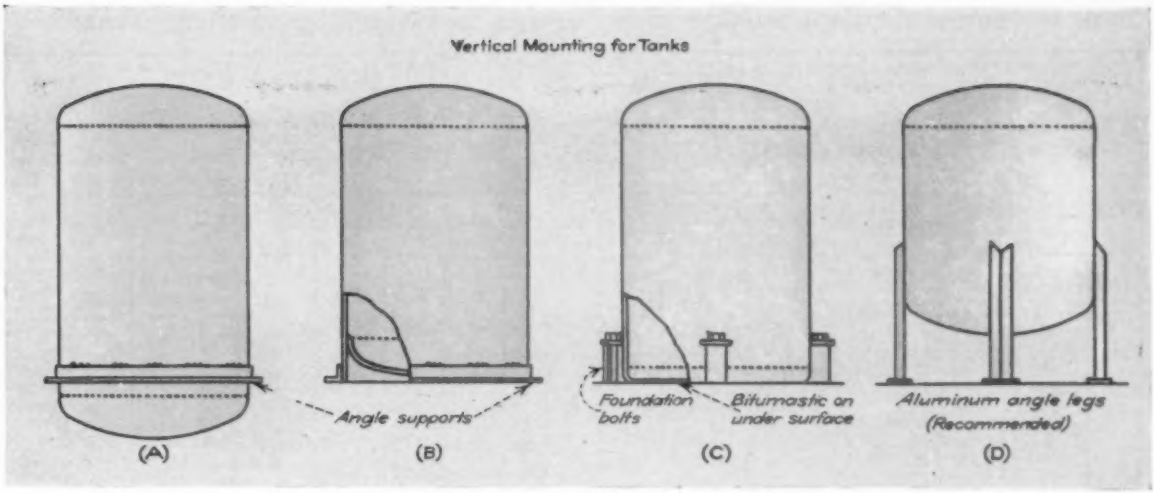
Sound Damping. Escaping air, under high pressure in pneumatic driven equipment, formerly was released through small openings in the housing, resulting in objectionable noise. In addition to protecting the mechanism against the entrance of dust, use of powdered metal filters in the escape openings permits an increase in their area, thereby reducing the intensity of the noise.

The above are but a few of the more common uses to which metal-powder filters have been adopted. Complete discussion is, of course, impossible in any one article.

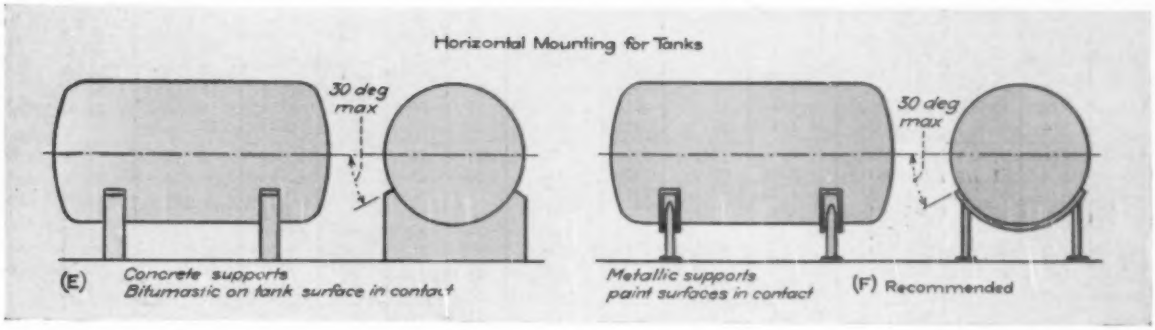
Fig. 5—Details of the fuel tank filter used on all Chrysler car models. Sloshing action of the gasoline keeps the filter clean.

Fig. 6—A porous filter is used to transfer oil from the bowl shown here to a passing air stream. Filter porosity controls flow.





Aluminum Tanks and Pressure Vessels . . .


Horizontal Mounting for Tanks
30 deg max
30 deg max
(E) Concrete supports Bituminastic on tank surface in contact
Metallic supports paint surfaces in contact
(F) Recommended

• • • Being used more frequently in the food, chemical, aircraft and transportation industries; they are light, corrosion resistant and readily designed and fabricated.

E. V. SHARPNACK, SR.
Reynolds Metals Company

Steel, which has been used almost exclusively for industrial tanks and pressure vessels, is being replaced in numerous instances by aluminum. There are several reasons:

1. Lightness is the obvious one. Although not a factor in many installations, it is of considerable importance in the aircraft and transportation field.

2. Corrosion resistance is another. In industrial atmospheres it withstands weathering well and is used to process, store, or transport such products as hydrogen peroxide, nitric acid (95 percent), distilled water, acetic acid, latex, fatty acids, essential oils, mineral oils, vegetable oils, petroleum products, paints, varnishes, resins, formaldehyde, glycerine, cellulose acetate, tartaric acid, and others.

3. Non-toxicity. This is a factor in the specification of evaporators, storage tanks, truck tanks and vats, and other similar equipment in the food processing and canning industry, and of similar equipment in the brewing industry.

4. High heat reflectivity and thermal conductivity properties are particularly useful where gas or liquid expansion or evaporation problems are present.

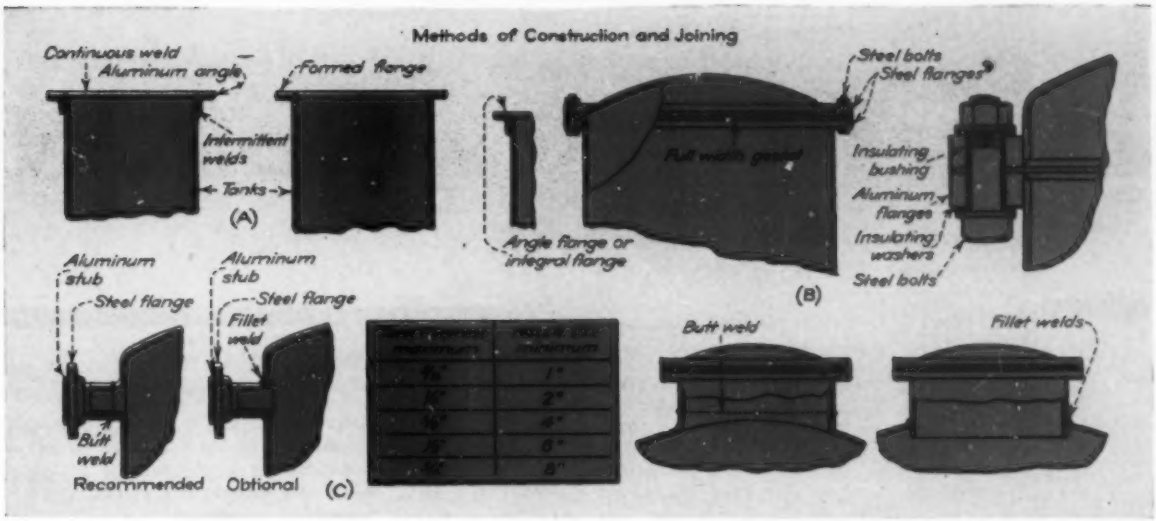
5. Finally, the non-sparking and high electrical conductivity of aluminum makes it desirable for tanks and equipment used for inflammable and explosive materials.

Table I—Dimensions, Capacity, Operating Pressures, and Weight of Aluminum Tanks[1]

A = Inside Diameter and Inside Length
T = Thickness
B = Side Wall Width
C = Side Wall Length
D = Inside Depth of Head
E = Flat Blank Size for Head

Dimensions, in.						Capacity	Max. Operating Pressure, 100 F psi				Weight		Cap per 1 in. of Cyl Length
A	T	B	C	D	E	Gal	99.5-O[2]	2S-O	3S-O	52S-O	Net Wt, Lb	Wt per 1 in. Cyl Length	Gal
36	0.102	19 3/4	113 13/32	8 1/8	44 1/2	140	17	19	23	34	53	1.156	4.40
	0.128	19 3/4	113 1/2	8 1/8	44 1/2	140	21	24	29	43	67	1.453	4.40
	0.162	19 3/4	113 19/32	8 1/8	44 1/2	140	27	30	36	54	85	1.840	4.40
	3/16	19 3/4	113 11/16	8 1/8	44 1/2	140	31	34	42	63	98	2.125	4.40
	1/4	19 3/4	113 7/8	8 1/8	44 1/2	140	42	46	56	83	131	2.847	4.40
	5/16	19 3/4	114 1/16	8 1/8	44 1/2	140	52	57	70	104	163	3.569	4.40
	3/8	19 3/4	114 1/4	8 1/8	44 1/2	140	63	69	83	125	196	4.285	4.40
	7/16	19 3/4	114 15/32	8 1/8	44 1/2	140	73	80	97	146	229	4.932	4.40
48	0.128	27 5/8	151 3/16	10 3/16	58	330	16	18	21	32	120	1.935	7.83
	0.162	27 5/8	151 9/32	10 3/16	58	330	20	22	27	41	152	2.451	7.83
	3/16	27 5/8	151 3/8	10 3/16	58	330	23	26	31	47	175	2.831	7.83
	1/4	27 5/8	151 9/16	10 3/16	58	330	31	34	42	63	234	3.789	7.83
	5/16	27 5/8	151 3/4	10 3/16	58	330	39	43	52	78	292	4.735	7.83
	3/8	27 5/8	151 31/32	10 3/16	58	330	47	52	63	94	351	5.699	7.83
	7/16	27 5/8	152 5/32	10 3/16	58	330	55	60	73	110	410	6.649	7.83
	1/2	27 5/8	152 11/32	10 3/16	58	330	63	69	83	125	469	7.618	7.83
60	3/16	35 1/2	189 1/16	12 1/4	71	650	19	21	25	38	269	3.465	12.30
	1/4	35 1/2	189 9/32	12 1/4	71	650	25	28	33	50	360	4.732	12.30
	5/16	35 1/2	189 15/32	12 1/4	71	650	31	34	42	63	449	5.911	12.30
	3/8	35 1/2	189 21/32	12 1/4	71	650	38	41	50	75	540	7.112	12.30
	7/16	35 1/2	189 7/8	12 1/4	71	650	44	48	58	88	630	8.297	12.30
	1/2	35 1/2	190 1/16	12 1/4	71	650	50	55	67	100	720	9.503	12.30
	5/8	35 1/2	190 1/2	12 1/4	71	650	62	69	83	125	918	11.904	12.30
	3/4	35 1/2	190 7/8	12 1/4	71	650	70	82	100	150	1102	14.314	12.30
72	3/16	43 1/2	226 25/32	14 1/4	84	928	16	17	21	31	393	4.241	14.91
	1/4	43 1/2	226 31/32	14 1/4	84	928	21	23	28	42	525	5.674	14.91
	5/16	43 1/2	227 5/32	14 1/4	84	928	26	29	35	52	656	7.087	14.91
	3/8	43 1/2	227 3/8	14 1/4	84	928	31	34	42	63	788	8.526	14.91
	7/16	43 1/2	227 9/16	14 1/4	84	928	36	40	49	73	919	9.944	14.91
	1/2	43 1/2	227 3/4	14 1/4	84	928	42	46	56	83	1051	11.388	14.91
	5/8	43 1/2	228 5/32	14 1/4	84	928	52	57	70	104	1314	14.260	14.91
	3/4	43 1/2	228 9/16	14 1/4	84	928	62	69	83	125	1577	17.141	14.91
84	3/16	51 5/8	264 15/32	16 3/16	97 1/2	1728	13	15	18	27	534	4.945	24.00
	1/4	51 5/8	264 21/32	16 3/16	97 1/2	1728	18	20	24	36	714	6.617	24.00
	5/16	51 5/8	264 7/8	16 3/16	97 1/2	1728	22	25	30	45	891	8.264	24.00
	3/8	51 5/8	265 1/16	16 3/16	97 1/2	1728	27	30	36	54	1071	9.944	24.00
	7/16	51 5/8	265 1/4	16 3/16	97 1/2	1728	31	34	42	63	1248	11.592	24.00
	1/2	51 5/8	265 15/32	16 3/16	97 1/2	1728	36	39	48	71	1428	13.273	24.00
	5/8	51 5/8	265 27/32	16 3/16	97 1/2	1728	45	49	60	89	1784	16.616	24.00
	3/4	51 5/8	266 1/4	16 3/16	97 1/2	1728	54	59	71	107	2151	19.969	24.00
96	3/16	59 1/2	302 3/16	18 1/4	110	2660	12	13	16	23	689	5.651	31.39
	1/4	59 1/2	302 3/8	18 1/4	110	2660	16	17	21	31	922	7.559	31.39
	5/16	59 1/2	302 9/16	18 1/4	110	2660	20	22	26	39	1150	9.440	31.39
	3/8	59 1/2	302 3/4	18 1/4	110	2660	23	26	31	47	1383	11.353	31.39
	7/16	59 1/2	302 31/32	18 1/4	110	2660	27	30	37	55	1611	13.239	31.39
	1/2	59 1/2	303 5/32	18 1/4	110	2660	31	34	42	63	1884	15.158	31.39
	5/8	59 1/2	303 9/16	18 1/4	110	2660	39	43	52	78	2305	18.972	31.39
	3/4	59 1/2	303 15/16	18 1/4	110	2660	47	51	62	94	2782	22.796	31.39
108	3/16	67 3/8	339 7/8	20 5/16	124	3140	10	11	14	21	879	6.355	39.60
	1/4	67 3/8	340 1/16	20 5/16	124	3140	14	15	19	28	1176	8.502	39.60
	5/16	67 3/8	340 1/4	20 5/16	124	3140	17	19	23	35	1467	10.616	39.60
	3/8	67 3/8	340 15/32	20 5/16	124	3140	21	23	28	42	1764	12.767	39.60
	7/16	67 3/8	340 21/32	20 5/16	124	3140	24	27	32	48	2055	14.986	39.60
	1/2	67 3/8	340 7/8	20 5/16	124	3140	28	31	37	55	2352	17.043	39.60
	5/8	67 3/8	341 1/4	20 5/16	124	3140	35	38	46	69	2940	21.328	39.60
	3/4	67 3/8	341 5/8	20 5/16	124	3140	42	46	55	83	3538	25.623	39.60
120	3/16	75 1/4	377 9/16	22 3/8	137	4350	9	10	13	19	1093	7.061	48.90
	1/4	75 1/4	377 3/4	22 3/8	137	4350	13	14	17	25	1461	9.444	48.90
	5/16	75 1/4	377 31/32	22 3/8	137	4350	16	17	21	31	1823	11.792	48.90
	3/8	75 1/4	378 5/32	22 3/8	137	4350	19	21	25	38	2192	14.181	48.90
	7/16	75 1/4	378 11/32	22 3/8	137	4350	22	24	29	44	2554	16.534	48.90
	1/2	75 1/4	378 9/16	22 3/8	137	4350	25	28	33	50	2922	18.928	48.90
	5/8	75 1/4	378 15/16	22 3/8	137	4350	31	34	42	63	3653	23.684	48.90
	3/4	75 1/4	379 5/16	22 3/8	137	4350	37	41	50	75	4352	28.451	48.90

[1] Does not conform to ASME Code For Unfired Pressure Vessels. [2] 99.5-O is 99.5% pure aluminum in the annealed condition.



Design and Fabrication

Aluminum pressure vessels often must be designed to meet specific codes, such as the ASME Code for Unfired Pressure Vessels, and in such instances certain designs and regulations must be followed to insure complete compliance even though the vessels constructed as herein recommended may serve the purpose as efficiently.

A single cylindrical tank having spherical heads with accompanying comprehensive data to enable the ready selection of a tank to meet a specific chemical or physical requirement is illustrated in Table I. The operation pressures listed are based upon a factor of safety of 4. The capacities of flat or conical bottom tanks can be readily determined by a few additional calculations.

The accepted method of supporting vertical and horizontal tanks are shown on page 183. It should be noted that where the tanks are in contact with the ground or supporting materials other than aluminum a bitumastic coating must be applied to the contacting surfaces to prevent corrosion.

The methods of flanging the open end of a tank are shown in (A) above and are employed whether the tank is to be left open or have a bolted cover.

Manhole and removable heads for vessels operating under internal pressure must be designed to insure tightness. Aluminum must be more rigidly supported in bolted joints than steel. It is generally satisfactory to use steel bolts, and steel washers must be used under the bolt head and nut in the absence of a steel back up flange. All steel parts should have all scale or rust removed prior to the application of a suitable primer. After assembly all exposed steel parts should be given a finish coat of aluminum paint. Where galvanic action is liable to occur, gaskets and bushings of a neutral material should be employed to insulate the steel from the aluminum. Illustrated in (B) above are the methods of construction and joining of heads.

The attaching of pipe connections should be accomplished as shown in (C) above and of the two methods shown the butt weld is recommended. The necking of the vessel and the joining of pipe connections or manhole type covers by this method tends to minimize the distortion of the tank due to the welding, however, the optional method shown may be used for material thicknesses greater than $\frac{3}{16}$ inch. Aluminum stubs with forged steel flanges are recommended and are standard products with many manufacturers of pipe fittings.

Recommended types of joining, the welding wire alloy and size, and the estimated consumption of welding wire when using either oxyhydrogen or oxacetylene gas are shown below. If Heliarc welding is employed, the inclusive bevel angle should be 50 to 70 deg, in which case the filler wire consumption will be approximately 54 percent less. For Airomatic welding the inclusive bevel angle should be 25 to 40 deg and filler wire consumption will be approximately 78 percent less. If oxyhydrogen or oxacetylene gas is used, all completed welds should be immediately and thoroughly cleaned to remove all flux residue.

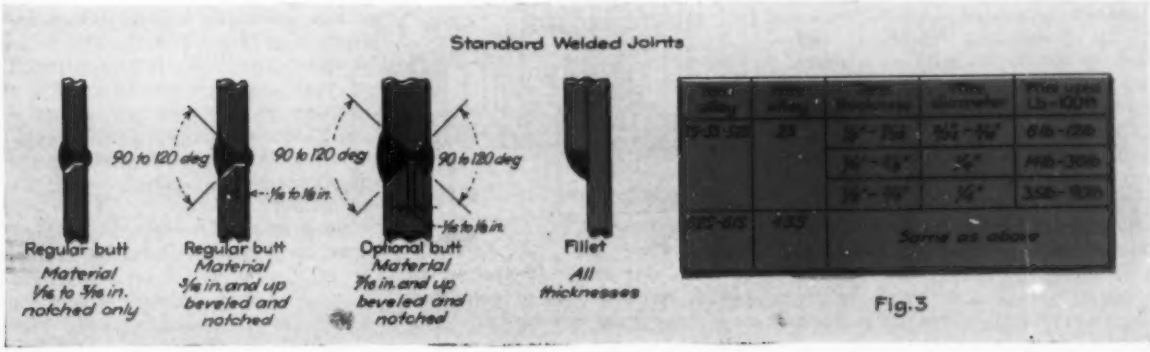


Fig. 3

The New

Editor's Note: **As a nationally known patent attorney and head and director of many first line industrial companies, Colonel Toulmin has been directly concerned with patent law for many years. Currently head of Commonwealth Engineering Company, Dayton, Ohio, which is engaged in research on such varied enterprises as hydraulic presses, noise spectrometers, electronic power suppliers and blood plasma extenders, he has made a comprehensive analysis of the effect of the new law on all aspects of engineering and business. He authored the book "Patent Handbook," and will be remembered for his two-part report, "Patents and the Engineer," which appeared in 1948 in the June and July issues of *Product Engineering*.**

IF YOU THINK that you have discovered a new use for an old product or process, you stand to make some money by it—so says the New United States patent law which went into effect on January 1, 1953. In the first major revision of the patent laws since 1870, this new ruling is just one of the many important changes that will affect design engineers, manufacturers, and research men alike.

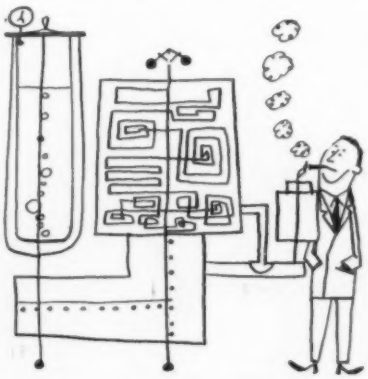
The whole philosophy of the new law is realistic. It is adjusted to the way that the United States does its engineering, research and its manufacturing. For instance the word "patentee" now includes not only the inventor to whom the patent was issued, but also his successor in title to the patent.

Likewise, a new and clearer standard of invention has been established. It is now recognized to be any new and useful process, machine, or composition of material, or any new and useful improvement thereof. This settles the old dispute whether a process is an art or whether the art is a process, and similar disputes over the meanings of words.

The courts have been defeating patents under the old law because of functional claims. The new statute eliminates this by approving that either a mechanical element or a step for performing a function will be valid when expressed as a means for performing a function, without supporting the statement with structure, material or acts. Such claims will cover what is disclosed in the application and equivalents thereof.

This new legislation has over-ruled many of the negative decisions against patent protection by the Supreme Court and lower courts of the United States. During the last 20 years the Courts proceeded on the basis that we were European manufacturers in which every manufacturer made everything from nuts, bolts, and screws, to the completed apparatus. The Courts did not recognize that in the United States there exists a vast number of specialty manufacturers, each making in mass production a single part or a single piece of apparatus that might later be assembled into complete machines by other manufacturers. That point was ignored in the destruction of the principle of contributory infringement.

Invention Defined . . .



. . . Any new and useful process, machine, or composition of material, or any new and useful improvement thereof.

CONTRIBUTORY INFRINGEMENT. A few years ago, anyone who supplied a particular component to complete a patented product was just as much an infringer as one who made the entire apparatus. Many Justices of the Supreme Court of the United States thought otherwise, and contributory infringement protection practically ceased to exist.

Now, whoever sells a part of a patented machine, material, or apparatus used in a patented process which makes part of an invention, knowing it to be especially made for use in the infringement of a patent, is liable as a contributory infringer.

In other words, if you supply a specially built electric motor to fit a particular machine only, it is necessary to determine whether there is a patent existing covering the entire machine which your customer does not own and under which he has no license. Under this law, you must be sure you are not helping or encouraging your customer to infringe somebody elses patent.

The law goes even further, because it says, "Whoever actively induces infringement of a patent shall be liable as an infringer." So, if your salesmen or your engineers should induce a customer to buy your special equipment, especially designed for his combination which is covered by a patent of another, your company would be an infringer.

Some of the favorite devices originated by the United States Courts during the last twenty years was to relieve for contributory infringement of a patent on the ground that one who

Patent Law of 1953

H. A. TOULMIN, JR.

Contributory Infringement . . .

. . . Whoever sells part of a patented machine, material or apparatus used in a patented process making part of an invention, is liable as a contributory infringer.

attempted to control unpatented, specially built parts through a suit for contributory infringement was guilty of a violation of the Anti-Trust laws, and was guilty of misuse of the patent. Then his patent was defeated on the ground that the manufacturer who sold such a component, which was unpatented, was guilty of misuse or illegal extension of the patent right over unpatented subject matter.

The new law says, however, that you cannot have your patent rights defeated on the ground of misuse or illegal extension of the patent right, because you are supplying, or licensing, one or more parts, especially designed to fit the customer's needs. The law also says that you can have relief against an infringer who derives profit by the manufacture of a part or material that is especially designed to fit your patented product. You can license another person to manufacture these parts of your equipment without jeopardizing your rights.

Great possibilities for both profit and loss arise for those who would take the essence of a patent by the manufacturing of the profitable components of the combination.

Thus, the Supreme Court defeat of the Minneapolis-Honeywell Company, which tried to control the profitable part of making the switches on a stoker against competitors making similar switches for stokers, would be reversed under this new law. In that case, the Supreme Court held that, just because the manufacturers of the controls did not manufacture complete stokers, Minneapolis-Honeywell could not have any patent protection for their switches especially adapted for such mechanisms, as such switches were not patented *per se*.

RESEARCH LABORATORY INVENTIONS. Following the eras of mass production and mass merchandizing, another great economic development in the United States has been the growth of engineering and research departments that have been producing, through the combination of a large variety of technical skills, some of the greatest inventions of our time. The complexities of

Research Inventions . . .

. . . The courts cannot defeat a patent on an invention made in a research laboratory by a group of people attempting to solve a problem.

science and industry are such that the role of the single inventor with few facilities is passing, due to economic conditions. This fact has not been recognized, and courts have indicated that they would not protect inventions that were the result of so-called "mass research" or "mass engineering".

The new law says, "Patentability shall not be negatived by the manner in which the invention was made". Now it makes no difference whether the invention is produced by wealth or poverty, by an individual, or many men in a research team.

This leads to a development showing another single angle of patent recognition based on modern conditions. Now, we are dealing with organizations of varying size and large numbers of engineers and scientists as well as practical men. The company paying for their services in the field of development work has frequently been penalized by the difficulty of securing the signature of the inventor if he declined to sign a patent application. Likewise, it has been difficult at times to determine who were the joint inventors or sole inventors.

Under the new law, whenever an inventor refuses to sign an application for a patent, or cannot be found after diligent effort, the company or person to whom the inventor has assigned the invention may make application for the patent on his behalf on proof of the ownership of the invention. The owner of the invention may sign the papers and take whatever action is necessary to preserve his rights and the rights of the inventor, if any.

The new law also provides that, "If a joint inventor refuses to join in an application for patent, or cannot be found or reached after diligent effort, the application may be made by the other inventor on behalf of himself and the omitted inventor." Under such circumstances, the resulting patent will be issued "subject to the same rights which the omitted inventor would have

Patent Ownership . . .

. . . The owner of an invention can file an application on behalf of the inventor if he owns the invention and the inventor refuses to sign.

had if he had been joined. The omitted inventor may subsequently join in the application." If there is any error in joining a joint inventor, the Patent Office may permit the application to be amended when the new facts are discovered.

DIVISIONAL APPLICATIONS. It has been the practice, on occasion, for the Patent Office to require division of a single application into a number of divisional applications to cover separate inventions; then, if one of the divisional applications was issued ahead of the others, the Patent Office used the issued patent to defeat the unissued pending applications.

The new statute corrects this reasoning. It says, "A patent issuing on an application on which a division is required, shall not be used as a reference against a divisional application or against the original application if the divisional application is filed before the patent is issued on the other application." The statute also further provides that the divisional application shall be entitled to the benefits of the filing date of the original application.

Another improvement in this direction is that divisional applications do not have to be signed by the inventor. Frequently the inventor has left the employ of the manufacturer and cannot be located, and it is necessary to have the divisional application filed within a strict time limit. To correct this, the statute says, "If a divisional application is directed only to the subject matter described in the original application, the Commissioner may dispense with the signing and execution by the inventor."

The last quoted sentence takes away the power exercised by many judges to defeat patents, because it is claimed that there is more than one invention covered by the patent. If the Patent Commissioner issues the patent, that is the end of the question of how many inventions are within the scope of the patent.

On the subject of an application for reissue of a patent because of original defects or mistakes, or because a patentee has claimed more or less than he had a right to claim, the new law provides that there may be several reissued patents for the separate parts of the device patented, instead of the old patent being reissued into a separate entity. This improvement opens up many practical advantages, particularly in view of the fact that contributory infringement is again recognized by Congress in this statute. It may be very important to separate the reissue applications into separate patents so that the several parts will permit the prosecution of contributory infringers.

The rule established by a number of Courts was that if there were an invalid claim among the valid claims in a patent, then the court would defeat the patent, or not enforce it, or both, because no disclaimer had been filed as to the invalid claim.

The new statute changes this, or clarifies it, by providing that you can maintain an infringement action, even though some of the claims are invalid. But if you do not disclaim the invalid claims before commencement of the suit, you cannot recover your costs, if you win the suit.

FOREIGN APPLICATIONS. Atomic energy has left its imprint upon the new Patent Law. The advent of other great, secret inventions show their influence upon the thinking of Congress in drafting this act. First, it is still the law that an invention will be protected by a patent, if the invention was not known or used by others in this country, or patented or described in a publication in this or a foreign country before the date he can prove he invented it, or more than one year before the date of the application for patent. Such a public disclosure must have been made by way of sale in this country, or a description in a publication anywhere more than one year before filing an application for a patent in the United States, or before the actual date of invention, in order to defeat a United States Patent.

This means that a prior use abroad cannot defeat the United States Patent, provided the alleged inventor did not know about it. If, by priority of invention in this country, there is another person who has not abandoned or concealed his invention, it will defeat the patent. If the inventor did not invent the subject matter sought to be patented, the patent will be invalid. If the invention was described in a patent held by another person before the invention by the applicant of the patent, the patent will be defeated.

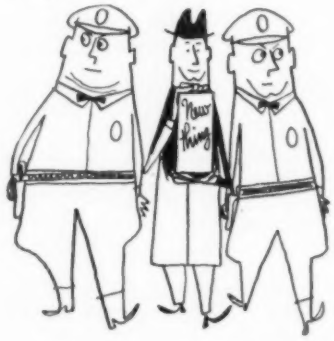
The patent will be defeated if the invention which it covers was first patented by the applicant in a foreign country prior to date of application in this country, or an application in the United States. In other words, when a foreign application has been filed, the inventor must file in the United States within twelve months from the date of the application on which the foreign patent will be issued.

An important new provision of the law is that a foreign patent will not stand as a bar against the issuing of

Foreign Applications . . .

. . . American inventors shall not file an application for a patent in any foreign country until six months after filing an application in the United States.

Secrecy . . .



. . . In view of the problems of National Security, a license for exporting a patent application is required.

Anticipation of a Patent . . .

. . . An application for a patent cannot be defeated unless the device was known or used by others in this country before its invention.

the United States patent in any case where the foreign patent was issued after filing in the United States.

If you are a foreign inventor, in order to date back your rights to a patent and secure your foreign priority, so you can have the benefit of the application date in your home country, it is necessary to file your application in the United States within twelve months from the earliest date that the foreign application was filed. A claim for priority must be made, and a certified copy of the original foreign application must be filed before the United States patent issues. These must be filed in the Patent Office to prove your priority as a foreign inventor.

American inventors who file an application in foreign countries, based upon a United States Patent application, are met by a new provision in the law. "Except when authorized by the Commissioner of Patents, a person shall not file an application for a patent or registration of a utilities model, industrial design, or model of an invention made in this country in any foreign country until six months after filing in the United States." This authorization shall not be granted without the concurrence of the head of the departments and chief officers of the Agencies of the Government who have issued such an order or restriction.

SECRECY. The new law recognizes the problems of National Security. It provides for the secrecy of certain inventions and the withholding of the patent publication to protect the nation. The right to prevent the disclosure by filing the application abroad is, therefore, under strict control.

The Commissioner of Patents has the power to make an application for a patent available for inspection by the Atomic Energy Commission, the Secretary of Defense, and the Chief Officer of any other department or agency of the government designated by the President of the Defense Agency of the United States. This slams the door shut on one of the principal leaks of our scientific and inventive brains.

Upon representation of any government agencies so designated, the Commissioner may seal up the application and notify the applicant. This secrecy shall extend to not more than one year, and is subject to renewal at yearly periods. However, if the United States is at war the secrecy order shall remain in effect for the duration of hostilities and one year after the end of hostilities. Provision is made for compensating the inventor or the assignee.

The law is also now clarified so that in proceedings in the Patent Office and Courts, an applicant for a patent may not establish his date of invention by referring to knowledge or use in a foreign country, except where he submitted a certified copy of any application filed abroad within one year before he has filed in the United States.

Generally speaking, the right to rely upon any foreign date by any foreign inventor or United States inventors with reference to unpublished knowledge or prior use of the invention in a foreign country is eliminated. This reverses decisions of the Supreme Court of the United States on this subject. Most of the major decisions that have restricted the rights of inventors are either seriously restricted, modified or reversed by the new Patent Act.

No better indication of this is the

New Use for Old Product . . .

. . . A new use for an old process, machine, or product can be patented even though the subject is already patented for other uses.

care with which the statute defines invention as meaning an invention or discovery. It eliminates by statute the so-called "flash of genius" theory and the other artificial standards of invention established by the Court in the last twenty years. It defines the term "process", as any process, art or method.

Most important of all, a new use of a known process, machine, manufacture, composition of matter, or mate-

Patentability of a Process . . .

. . . The law is now clarified to cover a chemical as well as a mechanical process in addition to new uses for old products or processes.

rial can be patented for the new use even though the subject is already patented for other uses.

This is the most significant phase of the entire law. Any existing process, article of manufacture, methods, material, machines, composition of matter patented, or un-patented found to have a new use not disclosed heretofore, can be repatented for the new use. This opens up an enormous area of invention and encourages new uses for the public benefit of the millions of inventions already made.

Congress has been very practical. It recognizes that all developments and inventions that have been created before are just new tools which the inventor, the engineer, the scientist, and the manufacturer can put to work on new things, even though the mechanism of the thing itself has already been made public, is patented, or is old. That, essentially, is a law for a practical people such as we. One who can find a new use for our past accomplishments, thereby increasing the effectiveness of our economy and expanding our scientific and manufacturing activities, can be blessed with patent monopoly for seventeen years.

Improving Fatigue Resistance

Available data on the design of bolts and bolted joints can be divided into the following categories: (1) Choice of materials; (2) Physical shape and relative proportions; (3) Surface finish and heat

1. Selecting Bolt Materials

Desirable Properties

(a) Low notch sensitivity
(b) Medium damping capacity
(c) Coarse grain structure
(d) High endurance limit
(e) High tensile strength

Acceptable Materials

(a) Low carbon steels
(b) Nickel steels
(c) Cr-Ni and Cr-Ni-Mo steels
(d) Nitrided steels
(e) 17ST and 24ST aluminum alloy.

2. Shape and Proportions

General Tips

(a) Rolled threads are up to 30 percent stronger than cut threads. Rolling threads after heat treating increases the useful life of parts.

(b) A more uniform thread pressure is obtained when the nut material is more yielding—has a lower modulus of elasticity—than the bolt.

(c) Fibers such as hemp packed between threads in areas of low load transfer reduces stress concentrations by distributing loads more uniformly.

(d) Tight connections maintained by self-locking nuts minimize impact effects.

3. Surface Finish

(a) Heat treating usually decreases fatigue strength. Reductions up to 40 percent have been recorded.

(b) Decarburizing reduces the endurance limit of a surface.

(c) Case hardening and nitriding improve fatigue life.

(d) Nickel and chrome plating to prevent corrosion reduces the endurance strength unless the plating is deposited in a stress-free state.

(e) Electrodeposited zinc increases the endurance limit but hot dipped zinc reduces it.

(f) Anodizing aluminum causes a reduction in endurance properties.

(g) Cold worked (rolled), highly finished surfaces seem best as far as fatigue life is concerned.

4. Assembly of Bolted Joints

Points of stress concentration and typical values for a bolted joint are shown in (*a*). When the external load varies periodically and thus introduces high fatigue stresses, the designer can reduce or even eliminate this effect by specifying a proper degree of initial tightening, see (*b*). For more detailed information see references listed on page 291. In non-torque-wrench assemblies the average initial tensile stress is of the order of $1.68\ K/\ (D\text{-}0.075)$ for coarse threads, and $1.47\ K/\ (D\text{-}0.062)$ for fine threads, where D is the nominal bolt dia and K is a parameter equal to 15,000-16,000. When gaskets or spring washers are used, they must be stiff or they will decrease rather than increase the fatigue life of the joint. With gaskets, the total force on the bolt, F, can be expressed as

$$F = F_i + \frac{K_{bolt}}{K_{bolt} + K_{gasket}} F_{external}$$

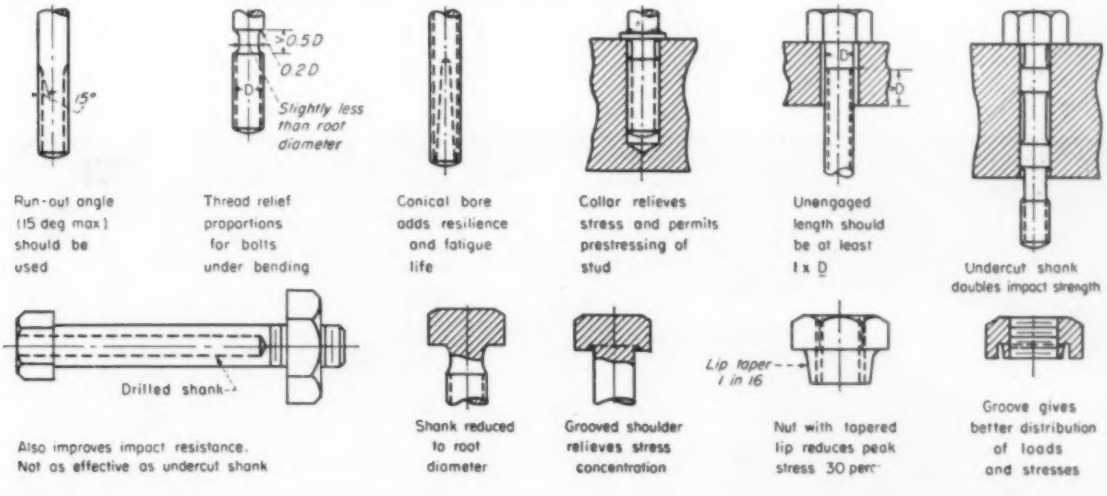
where K's are the stiffness constants of the bolt and gasket.

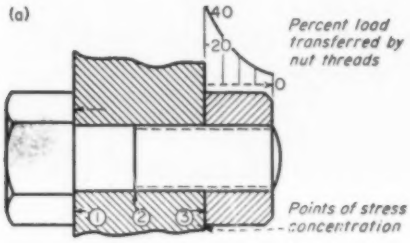
As shown in (*c*), the bolt is not affected by a varying load in a stiff-gasket joint if the initial tension is of sufficient (but safe) magnitude. With soft gaskets, (*d*), the total force varies directly with the external load.

# of Bolted Joints

J. P. VIDOSIC
Georgia Institute of Technology

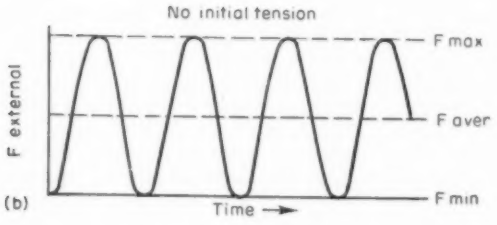
treatment; (4) Assembly of bolted joints for favorable stress distribution. The best practices with respect to each of these phases are summarized, with particular emphasis on improving fatigue life.

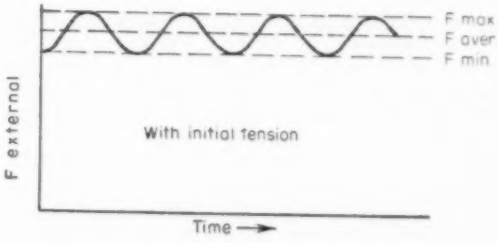

15°
Run-out angle (15 deg max) should be used
0.5D
0.2D
D
Slightly less than root diameter
Thread relief proportions for bolts under bending
Conical bore adds resilience and fatigue life
Collar relieves stress and permits prestressing of stud
D
D
Unengaged length should be at least 1 x D
Undercut shank doubles impact strength
Drilled shank
Also improves impact resistance. Not as effective as undercut shank
Shank reduced to root diameter
Grooved shoulder relieves stress concentration
Lip taper 1 in 16
Nut with tapered lip reduces peak stress 30 perc
Groove gives better distribution of loads and stresses

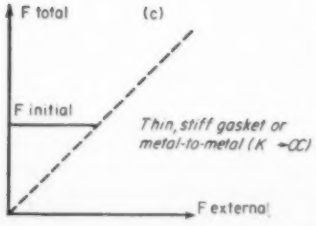


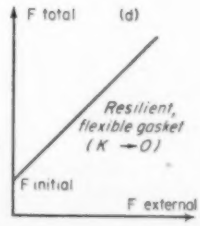
Stress concentrations occur at points shown. Table contains indicative concentration factors at each point

Thread	Form stress factor		
	①	②	③
Am. std	2.5	2.4	5.0
Whitworth	2.5	1.6	3.35









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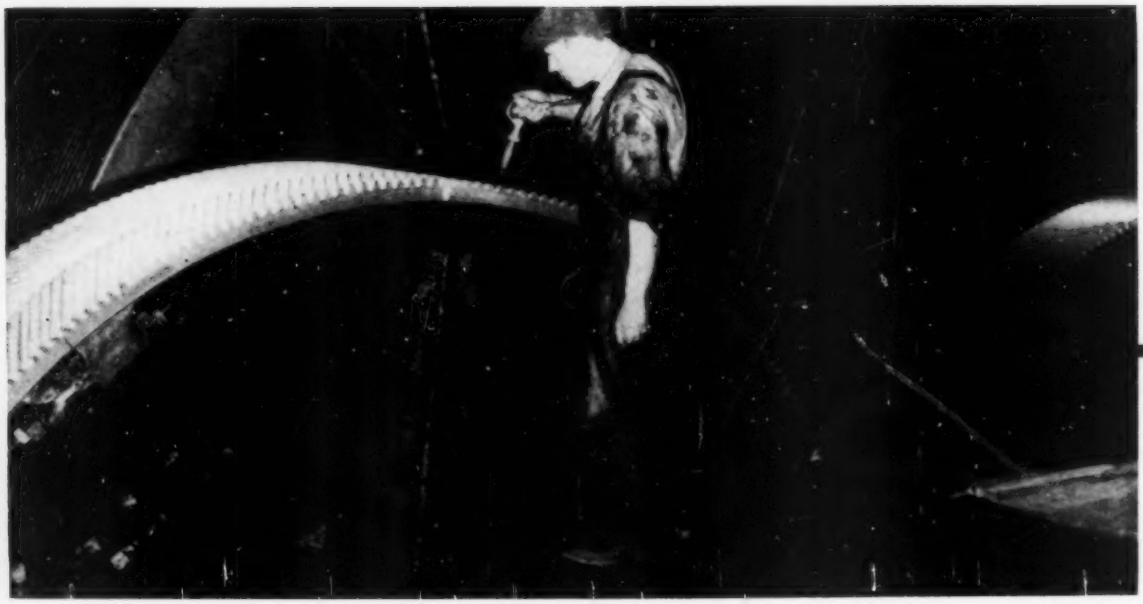
Brittle Structural With Emphasis



SHIP FAILURES of the kind that have become all too frequent in recent years began, as is well known, with the introduction of welded hulls to replace the older and relatively trouble free riveted structures. It is apparent that some structural advantage offered by riveting was lost when welding was adopted; a loss so great that the ample factor of safety intended by the designers was reduced to less than unity.

One source of loss is the recognized ability of riveted joints to distribute the stress from otherwise concentrated loads by local plastic yielding of holes and rivets. Such adjustment of stress is not possible when adjacent plates are fused by welding. Load concentrations are inevitable and, when these loads act in the same direction as externally applied loads, the local residual stress may become very great.

Another and more general loss of strength arises from the residual stresses that are developed by welding. In joining two plates, the weld metal together with a considerable volume of metal on either side of the weld is heated to a high temperature and, being restrained by adjacent cold metal, cannot expand but must adjust in length by plastic compression to that of the cold metal. When the weld is completed and the metal cools, it seeks to contract. But being still restrained by the adjacent unheated metal, the cooling metal is residually stressed in biaxial tension with corresponding compressive stress in adjacent plate areas. Measurements indicate that this biaxial residual tensile stress developed by local heating may equal the static yield stress of the steel.

Both of these dangerous residual stress systems, of course, may possibly occur in areas where stresses from external loads are concentrated to create an extra vulnerable structure.

The manner in which residual stresses decrease or increase the strength of a structure is not easily demonstrated by conventional laboratory tests. Long practice has shown, however, that it is desirable to reduce the magnitude of welding stresses. The purpose of the several stress relieving operations in common use is sometimes to reduce warpage but, more often, to produce a stronger structure.

In welding cast iron, pre-heating of the casting is usually necessary to avoid spontaneous cracking. Pre-heating reduces the residual tensile stress in the vicinity of the weld because the temperature gradient between the

Failures on Welded Ships

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Service experiences and results of pertinent experiments to support the theory that welded structures fabricated from ductile steel fail by brittle fracture. Data show that susceptibility to the several common causes of brittle fractures in ductile metal such as fatigue, stress corrosion cracking, and biaxial tension can be reduced by the development and retention of residual compressive stress in vulnerable areas. Simple and inexpensive methods for reducing harmful residual stresses. Since welded ships are fabricated from ductile steel and the fracture origins of failed ship plates are brittle in character, ship failures are suspected of developing from several causes.

Fig. 1—Prestressing gear teeth by air hammer peening developed sufficient residual compressive stress to avert further tooth failure in a 12 foot diameter cast steel mining hoist gear.

hot and cold metal is reduced. Many welded production items, including complete locomotive frames, are "stress relieved" by oven-heating after welding. Practical "stress relieving" by uniform heating does not, of course, eliminate residual stresses but they can be reduced to equal the yield stress of the metal of the annealing temperatures. Neither pre-heating nor annealing appears practical in large structures such as ships.

Local stress relieving is often practiced by experienced welders. In its simplest form this operation consists of striking the weld near its end with a hammer after the weld has become black. The effect is to induce a temporary state of residual compression by plastic deformation, thus reducing the final residual tension below the spontaneous fracture level.

Table I—Tensile Properties of Several Metals in Shot Peened and Non-peened Conditions

Material and Condition	Shot Peened	Peening Intensity	Rockwell Hardness	Tensile Yield, 1000 psi	Tensile Ultimate, 1000 psi	Elongation, percent in 2 in.
SAE 4130, heat-treated to 175,000 psi	No	——	D53	178.0	195.0	5
	Yes	0.008-0.010A1	D55	167.5	192.5	5
SAE 4130, heat-treated to 125,000 psi	No	——	D50	130.0	139.2	10
	Yes	0.007-0.009A1	D48	121.0	139.0	10
Stainless "w", condition A	No	——	D46	109.0	139.5	8
	Yes	0.007-0.009A1	D46	111.5	141.5	6
Stainless "w", condition D	No	——	D53	152.5	167.0	8
	Yes	0.007-0.009A1	D54	154.0	176.0	9
Alclad 24S-T	No	——	E 96	49.0	64.7	16
	Yes	0.004-0.006A1	E 96	48.7	64.7	16
Magnesium alloy FSIH	No	——	E 81	31.6	43.0	5
	Yes	0.004A1	E 75	34.3	42.7	9

LABORATORY TESTS INADEQUATE

Attempts to measure the effects of residual stresses by conventional laboratory tests cannot succeed because, regardless of the magnitude and orientation, such stresses have little or no effect on the static tensile or impact strength of ordinary structural materials. The reason is that, since ordinary materials are ductile, sufficient general yielding occurs during laboratory tests to dissipate any residual stresses that may originally have been present in the region of the specimen where fracture is initiated. As long as they are judged by conventional static tests, the true significance of the effects of residual stresses will be misunderstood.

Many static tests have been made to compare the yield strength and tensile strength of normal specimens not prestressed and specimens prestressed by shot peening. The results of a few such tests made by Consolidated Vultee Aircraft Company (Ref. 1) in cooperation with the Research Laboratories Division of the General Motors Corporation are given in Table I. In the several pairs of specimens tested, there is no significant difference in ultimate tensile strength or in yield strength, and the differences in elongation are no greater than may be expected from any two specimens of similar material and heat-treatments.

It is probable that the surfaces of all tensile specimens are residually stressed in compression whether or not they are intentionally prestressed. Measurements of residual stress in tensile specimens (Ref. 2) that had been loaded slightly above their elastic limits showed the surfaces to be stressed in compression as a result of greater plastic extension of their surfaces than of their cores.

SPECIMENS UNAVOIDABLY PRESTRESSED

Numerous comparisons have also been made between the strength of shot peened and non-peened impact specimens, which included gun parts, carburized starter gears, and standard laboratory specimens of the bending and torsional types. In all these specimens, the applied stress caused sufficient local yielding to dissipate the residual stress induced by peening. One series of four Charpy keyhole specimens made of SAE 4640 steel was heat-treated to give Rockwell C 32-36 hardness, tensile strength 148,000 psi, reduction of area 54 percent, and elongation 19.5 percent. As would be expected, none of these specimens showed significant changes that resulted from shot peening because sufficient plastic yielding preceded fracture to dissipate the residual stress induced by peening. The angle of swing for each of the two non-peened Charpy specimens was 116 deg and for the shot peened Charpy specimens the angles were 115 to 116.5 degrees.

New systems of residual stresses are developed in tensile specimens during tests, as has been described, because plastic deformation is not uniform with respect to strain through the deformed section. A similar effect is no doubt observable in impact specimens, but since these new stresses result from the test loads and not directly from stress initially in the material, they will not be discussed further.

Due attention must be given, however, to any increase or decrease in initial residual stress by plastic yielding under normal loads or occasional overloads occurring in service. Such changes can and do result in deterioration or improvement of structure strength.

More precise knowledge of material behavior than is afforded by the usual laboratory tests is required in the design of structures in which material must be used efficiently such as aircraft and automobiles, or in which factors of safety are dissipated by fabrication processes such as in welded ships, or in which favorable residual stresses are lost and unfavorable residual stresses are developed by service deterioration such as in railroad rails and wheels. Such structures are characterized by more or less frequent failure in service, even though the material conforms to the most rigid specifications.

When the strength of materials is measured by tests in which plastic flow approaches zero, residual stresses are partially or entirely retained and their effects approximate the effect of stresses from external sources having the same magnitude and direction. Under low plastic yielding, therefore, the original residual stresses that are retained will increase or decrease the effective strength of a structure, depending mainly upon whether their tensile components act in the same or in the opposite direction to the tensile stresses from the external loads.

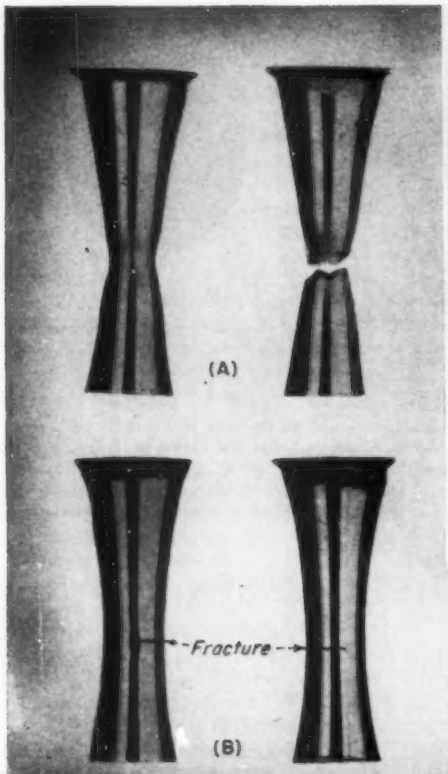
Accelerated fatigue tests in which fractures develop in less than 100,000 load applications usually mean that the test stresses are so great that extensive plastic yielding occurs. Such tests cannot be used to evaluate residual stresses resulting from prestressing operations because under reversed loading much or all of the prestress is lost, while under unidirectional loading the favorable residual stresses are increased somewhat as occurs in static strength tests.

SOURCES OF RELIABLE DATA

Data from arbitrary laboratory tests on arbitrary specimens are not only unreliable, but little confidence can be placed on data from so-called "simulated" tests. Service conditions cannot be reproduced in the laboratory even though the specimens are faithful copies of full scale structural elements. It is axiomatic that nothing can be learned relative to the ultimate strength of any particular structure, except from tests to failure.

The only source of reliable data is the "scrap pile". There, first hand studies may be made of true service failures in complete structures and under actual service operating conditions. "Scrap pile" data include the results of all manner of mistakes, accidents, and random experiences. The realistic interpretation of such data is the most fruitful source of new discoveries in engineering processes and of new knowledge for testing the validity of machine design formulas. It is in the scrap pile where clues are found that lead to the solution of many vexing problems and the foundations for more accurate theories.

Unfortunately, little use is made of the most productive source of reliable data. Instead, remedies for service troubles are almost invariably sought, at great expense, in laboratories through unreliable and misleading "simulated" tests.



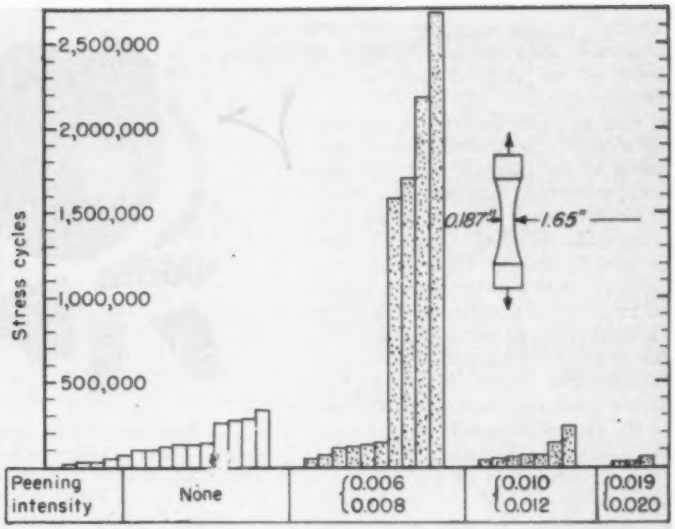


Fig. 2 — Typical tensile stress fractures in SAE 4340 steel specimens of 32-36 R. hardness. (A) Static tensile stress; plastic flow occurred before fracture. (B) Tensile fatigue; no apparent yield before fracture.

Fig. 3 — Relation between tension fatigue durability and shot peening intensity, as indicated by pull-pull fatigue tests on SAE 4340 steel specimens hardened and tempered to 33-36 R. hardness.

SHIP FAILURES ARE BRITTLE FAILURES

Studies seeking to determine the causes of and remedies for the numerous catastrophic failures that have occurred in welded ships have followed conventional laboratory methods. Test procedures have been based on erroneous concepts of causes of failure and little if any realistic correlation has been attempted between competent field observation and laboratory tests.

In the absence of data that could have been accumulated by trained observers, it is necessary for those who seek to prevent failures of welded ships to base their diagnosis on service and laboratory failures of other structures having similar characteristics.

Structural materials in the ordinary range of ductility fail by brittle fracture (low plastic yielding) when subjected to certain conditions that often prevail in service. These conditions are: (1) Repeated load (fatigue); (2) biaxial and triaxial tension; (3) simple tension in corrosive environment (stress corrosion cracking); and (4) tensile loads across sharp notches. In such situations residual stresses, depending upon whether they are tensile or compressive, can increase or decrease the effective stress tending to cause failures.

Ships and other welded structures are fabricated from ductile steel and since the fracture origins are brittle in character, their failures are suspected of developing from one or more of the foregoing enumerated causes.

Tensile fractures in SAE 4340 steel specimens heat-treated to hardness 32-36 Rc are shown in Fig. 2, (Ref. 3). The two specimens at the left were subjected to a static tensile stress and show extensive plastic yielding prior to fracture. Any residual stress in these specimens prior to testing would, of course, have been dissipated before fracture. The specimen strength would therefore be substantially the same whether or not they had been residually stressed. The two specimens at the right in Fig. 2 also show tensile fractures, but these were subjected to repeated tensile loads ranging from 32,000 psi nominal minimum stress to 150,000 psi nominal maximum stress.

The bar chart Fig. 3 gives the results of pull-pull fatigue tests on 0.187 in. dia non-peened and shot peened SAE 4340 steel specimens hardened and tempered to 33-36 Rc hardness.

These specimens were subjected to a calculated stress cycle of plus 32,500 psi to plus 150,000 psi. This maximum stress, which is slightly less than the static yield strength of the steel, was selected to assure that the peened specimens would fail in a short time. As stated in a previous article (Ref. 4), such short duration fatigue tests require the application of stresses well above the dynamic elastic limit.

As shown in Fig. 3, the cycles to failure in the group of non-peened specimens ranged from 25,000 to 320,000; the plastic extension averaged 0.0005 inch.

Plastic yielding, however, was not sufficient to dissipate the residual compressive stress induced in the surface of the ten specimens that were subjected to a light peening with chilled iron shot of 0.006 to 0.008 in. dia. The cycles to failure of four of these specimens ranged from 1,500,000 to more than 2,500,000. The greater

average fatigue durability of these specimens indicates the retention of some of the original residual compressive stress.

Lest this increased fatigue durability should be attributed to work hardening by the peening, note that more intense peening, and therefore greater work hardening, did not increase the fatigue durability of the specimens in groups three and four. The lesser effect of more intense peening appears to result from the greater loss of the residual compressive stress induced by the peening because, as the depth of the compressively stressed peened layer is increased, the residual tensile stress in the core is necessarily increased and the core area is decreased. As a result, plastic extension of the core increased and surface residual compressive stress decreased under the same applied load.

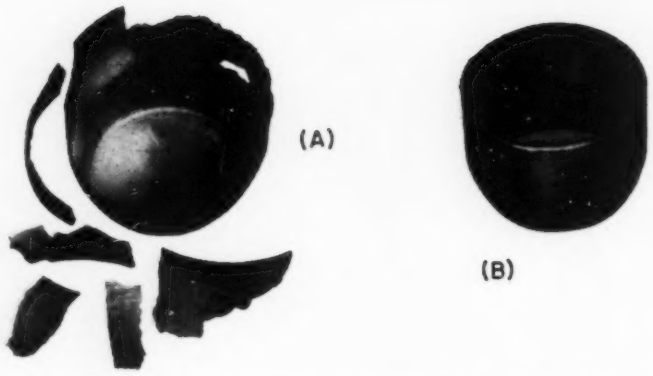


Fig. 4—Specimens, which were residually stressed by the dies in forming, used in studying season cracking in brass. (A) Non-peened brass case failed in 2½ hours in ammonia atmosphere. Stress corrosion cracking occurs only in tension stressed areas. (B) Undamaged lightly peened case after 100 hours exposure in ammonia atmosphere. Cracking is prevented when thin surface layer is compressively stressed.

SEASON CRACKING OF SHELL CASES

The brass cups shown in Fig. 4 are specimens that were used in studies to obtain a remedy for brittle cracking of shell and cartridge cases. The Research Laboratories Division of the General Motors Corporation; the Bureau of Ordnance, Navy Department; and the Springfield Armory (Ref. 5 and 6) cooperated in these studies.

These cups were residually stressed by the forming dies. Brittle fracture developed in the non-peened specimen, Fig. 4(A), after exposure in an ammonia atmosphere for 2½ hours. That this stress corrosion cracking (known as "season cracking" when occurring in brass) resulted from residual tensile stress is shown by the protection afforded the specimen, Fig. 4(B), by light shot peening. The thin layer of compressively stressed metal developed by the peening prevented failure although this cup was exposed in an atmosphere of ammonia for 100 hours.

This experiment was repeated many times with fracture occurring also in peened cups but only after prolonged exposure. Reason for failure was non-uniform peening; overpeening one portion of a cup developed tensile residual stress in some other region. When only one surface was peened fracture always developed in the unpeened surface.

Shot peening also prevented accelerated season cracking on unused shell cases, but the protective residual compressive stress was lost by the stress and heat of subsequent firing, after which the cases were again subject to season cracking.

STRESS CORROSION CRACKING OF MAGNESIUM

Shot peened and non-peened magnesium specimens have been tested to compare their resistance to stress corrosion cracking (Ref. 7 and 8). These tests were a part of a cooperative investigation by the Research Laboratories Division of the General Motors Corporation and the Aluminum Company of America. The specimens were of the strip form shown in Fig. 5. They were notched at the ends and were longer than the distance between the end lugs of the I-shaped magnesium holder, so that when assembled in the holder the strips were stressed in bending. The holder together with a non-peened and a peened specimen was immersed in a solution of 20 grams potassium chromate and 35 grams sodium chloride per liter of water and time to fracture measured.

The lower specimen, Fig. 5, which had been shot peened with small glass spheres, was still intact after twelve

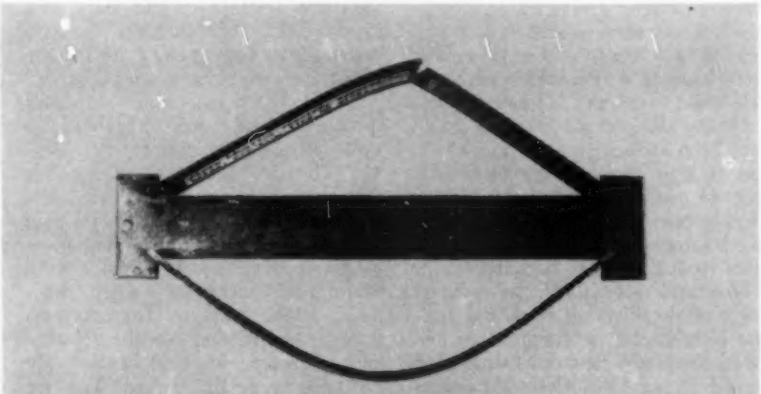


Fig. 5—Strip specimens and holder used in studying stress corrosion. Non-peened upper specimen failed in two minutes in salt solution. Stress corrosion cracking occurs only in tension stressed areas. Peened lower specimen is undamaged after twelve days in salt solution. Cracking is prevented when thin surface layer is compressively stressed.

days immersion. The non-peened upper specimen failed from a crack originating on its tensile stressed surface after two minutes in the salt solution.

It should not be assumed that the peened specimen was better than the non-peened by the ratio of 12 days to 2 minutes. The yield stress of magnesium under prolonged strain is indefinite, therefore, the effective peening stress decreased by plastic creep of the underlying metal. It was necessary to immerse the stressed specimens within a reasonable time after assembly in the fixture because, if too long delayed, enough of the peening stress was lost by plastic creep to interfere with the experiment.

Because of the creep characteristics of magnesium, and to a lesser degree aluminum, shot peening is not an effective preventive against (tension) stress corrosion cracking when these metals are tested under conditions of constant load, instead of constant strain as described for this experiment in which the magnesium strips were subjected to bending in the holder. When tested under constant load, the stress remains unaltered regardless of creep; whereas under constant strain, the stress decreases with creep. Under sustained load the protective compressive stress induced by peening is soon lost, and as creep continues the vulnerable surfaces become stressed in tension whereupon cracking proceeds as if peening had not been applied.

This experiment, supported by many similar ones, shows that stress corrosion cracking, which is in fact tensile corrosion cracking, is prevented as long as the magnesium surface is protected by a thin layer of compressively stressed metal.

STRESS CORROSION FAILURES IN STEEL

Similar accelerated stress corrosion experiments comparing peened and non-peened mild steel specimens and stainless steel specimens have been made by the Illinois Institute of Technology in cooperation with the Research Laboratories Division of General Motors Corporation.

These specimens were heat-treated after being bent to the form shown in Fig. 6. A number of specimens from each of several groups were then shot peened, after which test loads were applied by tie bolts adapted to bend the arms of the U-specimens toward one another, thereby stressing the outer surfaces in tension.

MILD STEEL SPECIMENS. The test loads in percent of static yield stress for each of the mild steel specimens (Ref. 9) are given in Fig. 7. The length of the respective bars indicate the relative time required to fracture the loaded peened and non-peened specimens when immersed in a boiling solution of

$Ca(N_3O)_2\ 4H_2O$	1800 gm
NH_4NO_3	100 gm
Distilled water	1200 gm

STAINLESS STEEL SPECIMENS. In testing the peened and non-peened stainless steel specimens (Ref. 10), the following test solutions for the corresponding groups of specimens shown in Fig. 8 were used:

Group A. 60 percent hydrated magnesium chloride, no acidification, *p*H 5.4, boiling point 114C.

Group B. 60 percent hydrated magnesium chloride, acidified with 1.5 percent citric acid *p*H3, boiling point 114C.

Group C. 60 percent hydrated magnesium chloride, acidified daily with

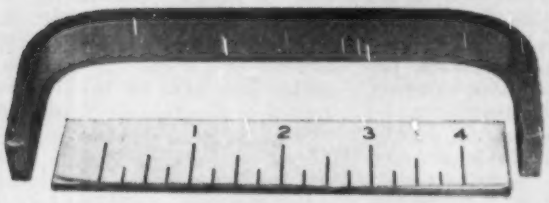
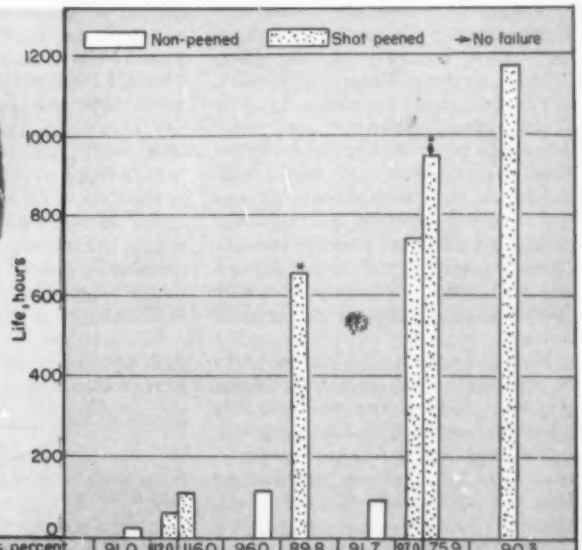


Fig. 6—Form of specimens used to study stress corrosion failures in steel. Specimens were heat-treated after being bent to the form shown. Test loads were applied by tie bolts that bent the arms of the U-shaped specimen inward, thereby stressing the outer surfaces in tension.



Stress, percent of estimated tensile strength	91.0	112.0	116.0	96.0	89.8	91.7	97.0	75.9	90.3
Number of cracks observed	10	4	3	2	1	2	2	0	1
Steel, astm.	Low carbon Bessemer			A89		A10			A212
Yield point, psi	78,700			69,600		99,400			103,500

* *Tie rod failed; specimen reloaded*
Note: Specimens examined every 12 hours during test

Fig. 7—Relative durabilities of mild steel U-specimens when immersed in a boiling solution of ammonium nitrate, calcium nitrate, and distilled water. The length of the respective bars indicate the relative time required to fracture the loaded peened and non-peened specimens.

N/10 hydrochloric acid to *p*H 2.2, boiling point 114C.
Groups D and E. 42 percent anhydrous magnesium chloride, no acidification, boiling point 140C.

One half of the shot peened specimens in each of the five groups A to E were peened after the external stress was applied by tightening the tie bolts (strain peening) and in the remaining half the external stress was applied after peening. The nominal test stress in all specimens was calculated to be 90 percent of yield stress. SAE steel 30915 was used for all specimens except those in the E group, which were of SAE 30805 steel. The relative durabilities of the specimens are indicated in chart, Fig. 8.

Strain peening was not more effective in resisting stress corrosion cracking in these statically loaded specimens than normal peening, because either process provided a "skin" that was residually stressed in compression and therefore impervious to intergranular corrosion. Under greater external static loads or in fatigue, strain peening (Ref. 11) can be superior to normal peening because the greater residual compressive stress will counteract greater applied tensile stresses when the latter are unidirectional or biased.

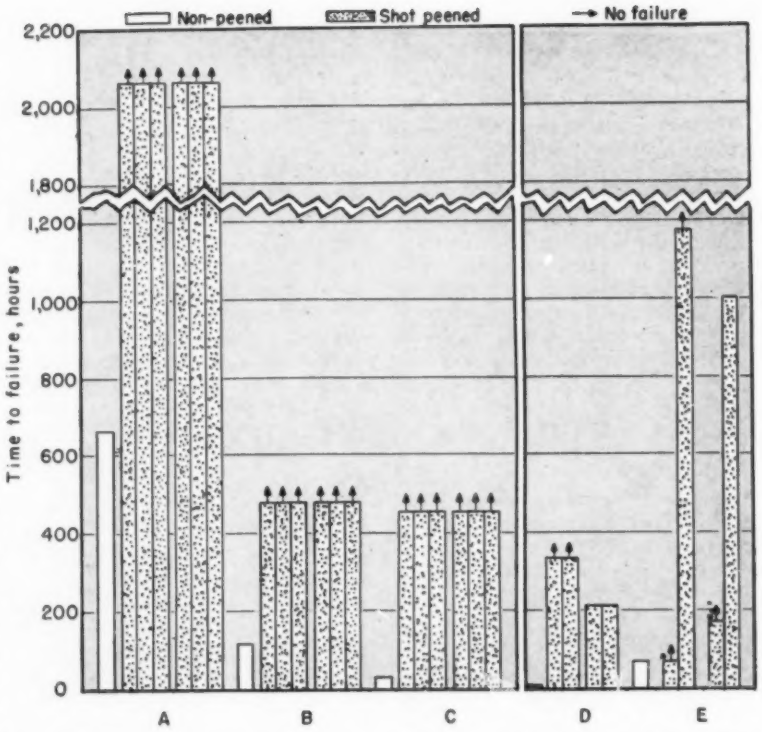


Fig. 8—Relative durabilities of stainless steel specimens when immersed in various boiling solutions. Tie bolts failed in two specimens of E group marked by asterisks.

STRESS CORROSION FREQUENT IN SERVICE

Numerous instances are recorded in which tension stress corrosion cracking has caused extensive trouble (Ref. 12) in service. These range from watch springs to suspension bridges. Watch spring strength was once thought to be affected by lightning because failures were most frequent in the season of thunderstorms. It was soon realized, however, that high humidity and therefore greater corrosion activity coincided with thunderstorms and that these frequently occurring failures were actually caused by stress corrosion cracking.

Similar frequent failures have occurred in such items as split lock washers, door lock springs and parts in which the metal is loaded at a sustained high stress. Only recently I found the spring of my seldom used bow pin broken. At McCook Field, Dayton, Ohio, about thirty years ago I observed the sudden collapse of an airplane parked unattended on the field. The welded landing gear had failed for no reason apparent at that time. A few instances of similar spontaneous failures will be given in which a reasonably accurate history of the failed specimens are known.

In the spring of 1929, numerous failures of wires were discovered in the cables of the 1200 foot span of the Mount Hope suspension bridge in Rhode Island and also in the cables of the 1850 foot span of the Ambassador suspension bridge between Detroit, Mich., and Windsor, Ontario. Both bridges were under construction at the time. The Mount Hope bridge cables had been completed and preparations were being made to lay the roadway. The Ambassador bridge cables were still being placed when the failures were discovered.

The method of construction was such that the tensile stresses from the applied load were augmented by bending stresses that approached or exceeded the elastic limit of the steel. As a result, brittle fractures developed from stress corrosion cracking in regions of high tensile stress. It was necessary, at great cost, to dismantle both bridges and to replace the original wire with wire more resistant to stress corrosion cracking.

Regardless of other prior induced mechanical or thermal residual stresses, a cold formed spring is residually stressed because the metal must be strained well above its yield strength when bending the wire to form a permanent arc. At the outside diameter of the coil, a layer of metal parallel with the neutral plane of the wire must be stressed beyond the yield strength in tension; also, at the inside diameter of the coil the metal in a similar layer must be likewise overstressed in compression. The bending stress in the metal between these overstressed outer and inner layers is proportional to the distance from the neutral plane of the wire and ranges from the yield strength of the material to zero. Although this layer is not plastically deformed, it contributes to the residual stress.

On release of the bending load, the radius of curvature of the coils increases to establish equilibrium between clockwise and counterclockwise residual stress moments about the axis of the spring. One result of this elastic recovery (springback) is that the layer of metal near the outer diameter of the spring, which yielded in tension, becomes residually stressed in compression; and the layer near the inner diameter, for a similar reason, becomes residually stressed in tension. These effects are easily observed by wrapping a wire (a straightened paper clip will do) around a pencil.

RESIDUAL STRESS FROM COLD FORMING

The residual stress in a cold formed spring is qualitatively indicated in the diagram, Fig. 9, in which a beam supported near its lower ends is loaded in a downward direction at *O*. The upper surface of this beam, which is stressed in compression by the downward acting load, represents the inner diameter of the coil spring. The lower surface, which is stressed in tension by the applied load, represents the outer diameter of the coil spring.

The nominal stress in the plane *OO'* of the beam is represented by the horizontal distance from *OO'* to the diagonal line N_tN_c. The nominal compressive stress on the upper surface of this beam from the applied load is indicated by the distance ON_c. The nominal tensile stress on the lower surface is indicated by the corresponding distance $O'N_t$. Nominal stresses at intermediate points are proportional to the distances from a central horizontal plane passing through the point *O''* and the respective points.

The compressive and tensile yield stresses are indicated by the lines *HB* and *KA* respectively. These lines are arbitrarily slanted to indicate greater yield stresses at the surfaces because of greater cold working of the material nearer the surface. The nominal compressive stress ON_c on the upper surface exceeds the yield stress of the material by an amount HN_c. The nominal surface tensile stress $O'N_t$ exceeds the tensile yield stress by the amount KN_t. Since the stress is limited by the yield strength of the material, the actual stress from the applied load is indicated by the Z-shaped line *KABH*.

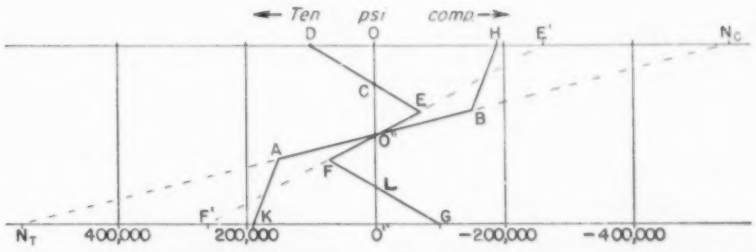


Fig. 9—Diagram of nominal stresses and residual stresses developed in cold forming a wire spring. Plastic bending develops dangerous longitudinal residual tensile stresses.

Upon removal of the downward acting load at *O*, the beam will recover elastically until a balance is established between the tensile and compressive acting residual stresses as is indicated by the Z-shaped line *DEFG*, Fig. 9. Equilibrium conditions are satisfied when the clockwise moments represented by the areas *CO''E* and *LO''F* are equal to the counterclockwise moments represented by the areas *DOC* and *GO'L*.

CRACKING OF COLD FORMED MEMBERS

A transverse brittle crack on the inner diameter of a coil taken from a multi-coiled cold formed spring is shown in Fig. 10. The spring was coiled from SAE 1365 steel wire having a diameter of $\frac{7}{32}$ in. The wire was heat-treated prior to forming to Rockwell C 42 to 48 and tempered after coiling to 550 to 600 F for 20 minutes. The crack shown in Fig. 10 is typical of hundreds of other such cracks that developed while cold formed springs were in a pickling bath or that developed in a short time after they were removed from bath.

This crack resulted from the residual tensile stress that was developed during cold forming as described in the preceding paragraphs and as shown in Fig. 9. The wire section at the right in Fig. 10 shows the crack depth to be approximately 25 percent of the wire diameter.

The manufacturer from whom these springs were obtained reported that such spontaneous failures occurred with alarming frequency and a quick commercial remedy was needed if possible, so that he could maintain his production schedule. Failures stopped immediately when the spring manufacturer changed the cleaning operation prior to zinc plating from acid pickling alone to grit blasting before pickling.

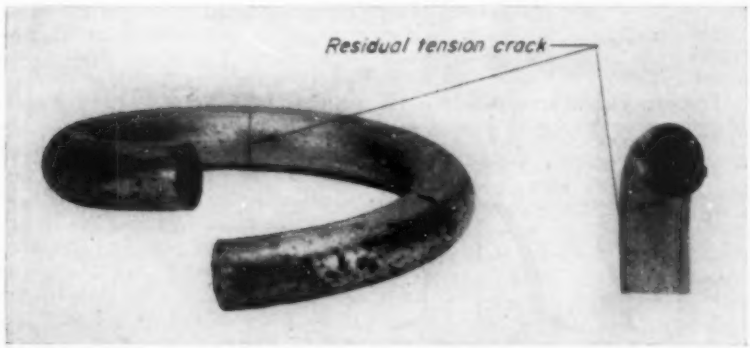


Fig. 10—Transverse fatigue crack on inner diameter of coil spring caused by residual tensile stress from spring-back after cold forming.

Grit blasting, like shot peening, induces residual compressive stress in the treated surface. The depth of the compressively stressed layer varies with the particle size and velocity but is usually quite shallow. Principal difference between these processes is the abrasive action of the sharp particles. Grit blasting, rather than shot peening, is therefore used for removing scale and rust and similar cleaning operations.

As did the brass cups, Fig. 4, the magnesium strips, Fig. 5, and the various steel corrosion specimens, Fig. 6, the springs, Fig. 10, failed by stress corrosion cracking caused by high residual tensile stress.

Grit blasting the springs provided a surface layer or skin that was impervious to stress corrosion cracking by reversing the residual stress in a thin layer on the inner surface of the coils from tension to compression.

Acid pickling was as effective as before in cleaning the surface of the cold formed springs but the formation of a deep compressively stressed layer was prevented.

PISTON PIN RETAINER FAILURES

Spring retainer rings, such as are shown in Fig. 11 (A), were used in engine pistons to limit the endwise movement of floating piston pins. To assemble, the rings were elastically contracted sufficiently to enter grooves in the piston bosses. Since the free spring diameter exceeded the outer diameter of the grooves, the springs remained statically stressed after being inserted in their respective grooves.

This method is a common and very satisfactory one for restraining floating piston pins, but trouble developed in some engines that were placed in storage immediately after being operated through a run-in schedule. When again operated after long storage, a few engines were damaged because one or more of the retainer rings were broken and the piston pin would rub against the cylinder wall.

Examination of engines after storage, but before subsequent operation, showed that occasional retainer rings had failed while in storage in the manner shown in Fig. 11 (B). The fracture details are clearly shown in Fig. 11 (C), in which it is seen that two brittle transverse cracks originated in the outer tension stress metal, and that one crack continued inward to the mid section of the wire where branching occurred.

Sufficient moisture, apparently, was deposited between the retainer rings and their grooves during the run-in period to initiate mild intergranular corrosion, not visible in the illustration, on the tension stressed outer surface of the spring retainer. It is known that the stress during storage was well below the nominal yield strength of the metal because during assembly the rings were contracted to less than their assembled dimensions. The stress and corrosion action, however, were sufficient to cause stress corrosion cracking that originated on the tension stressed outer surfaces of the snap rings.

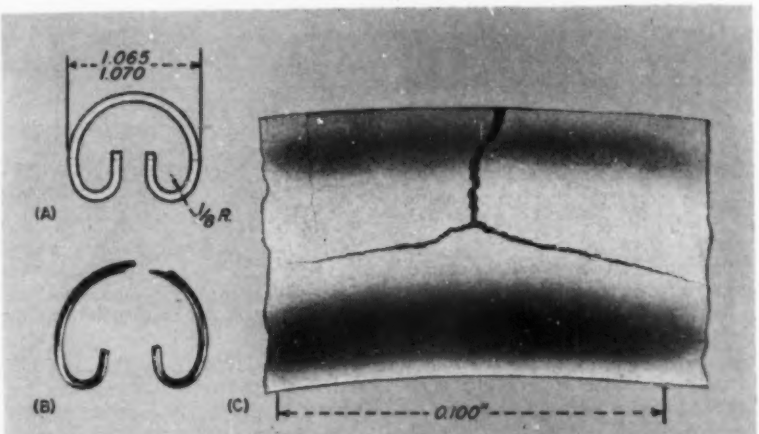


Fig. 11—Stress corrosion cracking in spring retainer ring. (A) Dimensions of spring retainer ring. (B) Method of failure. (C) Enlarged view of brittle transverse cracks.

Such failures did not occur in engines that were not placed in storage, presumably because normal operating temperatures were great enough to dry the spring surface and to partially relieve the stress by slow annealing.

GRINDING CRACKS

The several cracks seen in the ground gear tooth, Fig. 12, are typical of delayed fracture in ground surfaces (Ref. 13). The metal in contact with the high velocity grinding wheel at any instant becomes very hot, but the usual oxide discoloration is not seen because formation of a visible oxide film requires time and the heated area, when good grinding practice is observed, is so shallow that it is cooled too quickly by adjacent cool metal or by liquid coolant.

The shallow heated area is plastically deformed in compression because thermal expansion is prevented and this area must therefore conform to the dimensions of the underlying cold metal. Upon cooling and contracting, the heated layer becomes residually stressed in tension. The magnitude of this stress may exceed the ultimate strength of the metal, in which event a crack immediately appears. If the residual tension is less than the ultimate strength, the formation of cracks may be delayed until corrosion, usually not visible to the unaided eye, provides the necessary stress raisers.

Fractures such as are seen in Fig. 12 may therefore develop in ground surfaces at any time from the moment of grinding to a week or more in storage. As stated, the formation of cracks is often delayed until surface deterioration by atmospheric exposure, accelerated by high residual tensile stress, progresses sufficiently to initiate fracture.

In some factories, gears are annealed immediately after grinding to reduce surface residual tensile stress below that which will initiate stress corrosion cracks. The tensile stress in the surface after annealing, however, may still be so great as to be hazardous from the standpoint of fatigue, but the treatment is effective against spontaneous fracture if applied before actual cracks have appeared. The same protection against cracking can be had by immediate shot peening. This treatment is superior in that it converts the surface residual stress from tension to compression, thereby not only preventing tension stress corrosion cracking but also increasing the fatigue strength of the gear teeth.

Fig. 12—Transfer print of magnetic particle markings of a gear tooth showing surface fractures that resulted from grinding.

WELD FAILURES

During a critical period in the late World War failures of welded cooling fans, which were being supplied to the Buick Motor Division of General Motors Corporation, for use in Buick-built tanks became so serious that tank shipments to the war theater could not be made. In the hope of finding a quick remedy, a cooperative investigation was undertaken (Ref. 14) by Buick and the Research Laboratories Division of General Motors Corporation.

With the expectation that shot peening was almost certain to overcome the difficulty, a special production shot peening machine was designed, built, and in operation in forty-eight hours. The results of shot peening the welded fillets are given in the bar charts, Fig. 13, which also shows the fan in question. The tests were not continued long enough to determine the magnitude of the improvement in fatigue durability because shipments had to be made as soon as it became apparent that adequate life was available.

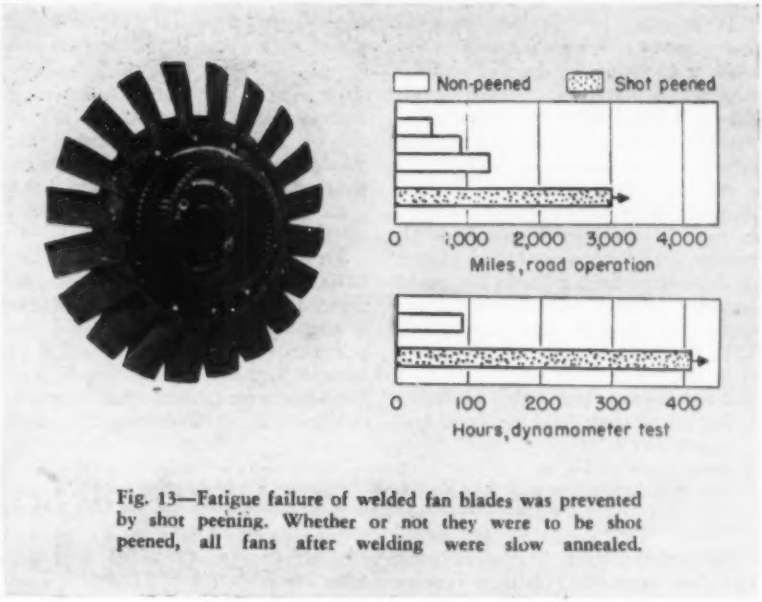


Fig. 13—Fatigue failure of welded fan blades was prevented by shot peening. Whether or not they were to be shot peened, all fans after welding were slow annealed.

Dynamometer operation at the critical speed caused failure of a non-peened fan in less than 100 hours, whereas the shot peened fan showed no distress when the test was stopped after more than 400 hours. Proving Ground tests gave similar results with no distress from the shot peened blades when the test was stopped after 3000 miles of test road operation.

The blades of these 34 in. dia fans were made of SAE 1025 steel. In all cases the welding process was selected and applied to produce a ductile fillet. After welding, whether or not they were to be shot peened, the fans were stress relieved by slow annealing. Each assembled fan was placed in a furnace at 300 F and temperature then increased 100 deg F per hour to 1180 F. This temperature was maintained for two hours and then reduced 100 deg F per hour until the fan was removed at 300 F to cool in air.

Shot peening operation was performed by the American Sand Blasting Company of Detroit in accordance with instructions by the Research Laboratories Division, General Motors Corporation. The peening intensity was 15-18A using chilled iron shot of 0.016-0.020 in. diameter (SAE No. 110). Small diameter shot were used in order that the desired residual compressive stress would extend into the grooves and folds of the weld metal.

RESIDUAL STRESS FROM FLAME CUTTING

Residual stress patterns such as result from welding are developed by all processes that create steep temperature gradients. In flame cutting, the temperature gradient may be steeper than in welding and the resulting biaxial residual tensile stress in the surface of the cut may be correspondingly greater.

A one half inch wide strip sawed from a flame cut plate ¾ in. in thickness is shown in Fig. 14 clamped to a straight edge. The saw cut followed a straight line with respect to the plate but the severed strip is seen to be sharply curved concave in the flame cut surface. The observed curvature of the strip is a qualitative measure of the longitudinal residual stress that resulted from the localized heat during flame cutting. This demonstration does not indicate stress magnitude but only that longitudinal tension near the cut surface was great enough to bend the strip, and in bending to develop residual tensile stress in and near the opposite surface as required to satisfy conditions of equilibrium.

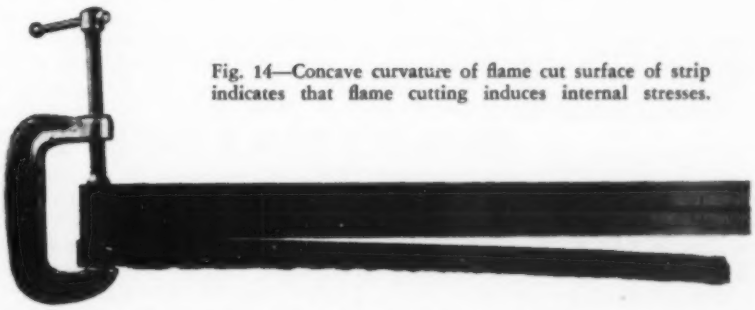


Fig. 14—Concave curvature of flame cut surface of strip indicates that flame cutting induces internal stresses.

Reliable residual stress measurements in flame cut surfaces have not been made, but it is highly probable that local tension equal to the yield strength of the metal is a common occurrence. It would not be surprising to find fractures originating in sharply notched flame cut surfaces that are exposed to corrosive environments, particularly when the residual tensile stress is augmented by tensile stresses from service loads. The probability of such fractures would be further increased if the external service load is of a recurring nature.

PRESTRESSING WITH HAMMER BLOWS

Prestressing by hammer peening, instead of by shot peening, is practiced when it is desired to develop residual compressive stress to a greater depth than is possible with shot; also, when peening must be applied to a portion of a complete machine.

An interesting example of the application of hammer peening is shown in Fig. 1. Early in World War II, broken gear teeth were found in one of three large hoist gears in a mine at Sudbury, Ontario, operated by the International Nickel Company (Ref. 15). These cast steel gears were 12 ft in dia, 30 in. face width, and had 288 herringbone teeth of 2 pitch.

Failure of teeth in these gears presented a most serious threat to the war effort. Nickel was in short supply and stoppage of the important Sudbury mine while new gears were being made would greatly reduce nickel production. Furthermore, since gear manufacturers were loaded to capacity with war orders, making new hoist gears would interfere with production of other important gears.

Through a cooperative effort by the Research Laboratories Division of General Motors Corporation and the International Nickel Company, the problem was solved by resorting to hammer peening. The portions of gear teeth that were cracked were removed, care being taken to cut away the entire cracked length in each fatigued tooth. The remaining unbroken lengths of teeth, together with all other teeth in each gear were hammer peened at the roots using spherical ended punches ¼ in. in dia. This treatment was first applied to the damaged teeth and later, as time permitted, to all of the unfailed teeth.

In the beginning, peening was applied by hand hammers because air hammers were not available, but eventually air hammers were obtained and the work progressed more rapidly.

The hammer peening proved highly successful and the gears served throughout the war without recurrence of fatigue cracks.

HAMMER PEENING OF SOFT STEEL

As part of a study to prevent costly and time consuming fatigue failures of large forge hammer bases, fatigue specimens such as that shown in Fig. 15 were prepared and tested. The purpose of the experiments was to determine whether deep hammer peening of soft steel, such as is used for forge hammer bases, could be expected to increase fatigue durability and, if so, to determine the order of improvement that might result. Peening was applied by air hammer, actuated by 50-psi air pressure, using a one inch diameter spherical ended tip.

The specimens were made from SAE 1030 steel fully annealed to a hardness of Rockwell 65 B. The 1¾ in. square test sections were machined from larger rectangular bars 2¼ x 2¾ in. in cross-section and 13½ in. long. During testing they were loaded in reverse bending to ±35,500 psi. Under this loading, the unpeened specimen at the left of Fig. 15 failed as shown after 130,000 stress reversals, the fracture being brittle in character despite the high ductility of the steel.

Under the same load conditions, the hammer peened specimen shown at the right of Fig. 15 completed 7,000,000 cycles of stress without failure although fine surface cracks appeared after 4,000,000 stress reversals. Note that the cracks, which in Fig. 15 have been broadened by pen, did not noticeably increase in depth during the 3,000,000 cycles of operation after they were first discovered. This is as would be expected unless much of the residual compressive stress induced by the peening had been dissipated by the reversed stresses from the applied loads. The cracks did not propagate; therefore, sufficient subsurface residual compressive stress remained to serve as a barrier to crack growth.

The peened specimen was later sawed from the side opposite the cracks until the remaining section could be broken to show the depth to which the cracks had penetrated. The depth was found to be approximately 0.030 inch.

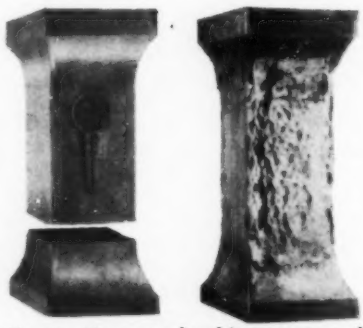


Fig. 15—Non-peened and hammer peened reverse bending fatigue specimens made of SAE 1030 annealed steel that were used in a study of forge hammer base failures.

DISSECTION STRESS ANALYSIS

To study further the effects of air hammer peening in inducing residual stresses in SAE 1030 annealed steel, dissection stress analysis was made of a specimen peened to the same intensity as the peened fatigue specimen of Fig. 15. The results of these stress measurements are indicated by the dash line in the diagram of Fig. 16. The induced residual compressive stress ranges from 21,000 psi at the surface to a maximum of 41,000 psi at a depth of 0.100 in. The residual tensile stress at the mid section is 24,000 psi. For purposes of dissection stress analysis, the surface of the specimen was assumed to be the bottom of the hammer depressions.

The two solid diagonal lightweight lines in the diagram represent respectively the plus and minus stresses from the externally applied bending loads. The heavy solid line represents the algebraic sum of the residual stress and the stress from the external load when acting to bend the beam concave on its upper surface as represented by the diagram.

The resultant stress near the upper surface of the diagram reaches a magnitude of 73,000 psi compression. If this resultant stress exceeded the macrodynamic yield strength of the metal, plastic yielding occurred and the residual compressive stress was reduced by an amount equivalent to such yielding. The magnitude of the remaining residual stress at the time the test was stopped can be determined only by dissection stress measurements of a specimen after undergoing long fatigue testing at the particular load in question. This has not yet been done.

The resultant stress near the tension (lower) surface is seen to be compressive at depths between 0.03 and 0.2 in. So long as no plastic yielding occurs from stress reversals (see upper

part of diagram), this lower layer and a corresponding layer near the upper surface cannot fracture because they are never stressed in tension (Ref. 13). It is also seen that plastic yielding equivalent to 10,000 psi can occur and still leave a subsurface barrier to crack growth because it will not be stressed in tension.

Because of the lesser residual compressive stress near the surfaces together with the greater applied stresses, however, surface fatigue cracks can develop on and near the tension (lower) surface since, as is seen from the diagram, in this region the resultant stress is tensile. Shallow cracks can therefore develop just as was seen to happen after 4,000,000 load reversals. It is probable that the fatigue strength of a layer of metal near the surface was adversely affected by the very severe cold working that was applied and therefore relatively low tensile stress initiated the observed surface cracks. It is seen that the measured depth of the cracks (0.030 in.) is in agreement with the depth of the metal stressed in tension.

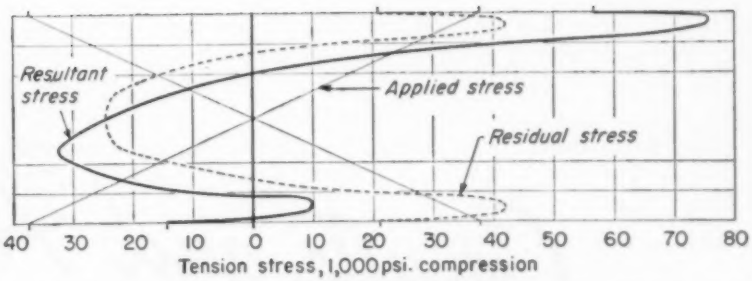


Fig. 16—Residual stresses induced in SAE 1030 annealed steel specimen by hammer peening, and resultant stresses acting at start of fatigue test.

The greatest resultant tensile stress is seen to occur about $\frac{3}{8}$ in. below the surface and, unless the stress values shown in the diagram are markedly changed by yielding, disastrous subsurface fatigue cracks can originate at this distance from either surface when the specimen is subjected to reverse bending. The tensile stress required to initiate fracture in subsurface metal, however, must be greater than the fracture stress in sound surface metal because of the greater fatigue vulnerability of surfaces (Ref. 4).

SHIPS FAIL FROM RESIDUAL STRESSES

It is probable that the susceptibility of welded structures to brittle fracture is influenced in varying degrees by many factors such as material, welding technique, and design. This article has considered only residual stresses, which are the most important causes of failure, and the means whereby harmful residual stresses can be reduced or converted to beneficial stresses. The treatment that is required is simple.

The data that have been presented show that susceptibility to the several common causes of brittle fractures in ductile metal such as fatigue, stress corrosion cracking, and biaxial tension can be reduced or eliminated by the development and retention of residual compressive stress in vulnerable areas. The same treatment will ameliorate the detrimental effects of bad design, inferior materials, and even bad welding.

Successful peening will require the services of skilled workmen not now available, but the skill needed does not differ greatly from the well developed art of peening large saws.

The data presented include a number of specimens that differed greatly in hardness and therefore in notch sensitivity from the materials used in welded structures. Experience has shown that because of notch sensitivity, shot peening is even more effective on hard steels than on the softer more ductile grades. Note, for example, the effectiveness of the shallow residual compressive stress induced by grit blasting of the hard spring, Fig. 10. On the other hand, because of its greater notch sensitivity, hard steel is more susceptible to stress corrosion cracking than soft steel. If the hardness is the result of nitriding or carburizing, however, hardened steel is not notch sensitive nor will it fail by stress corrosion cracking because its surface is compressively stressed by case hardening, thus giving the same effect as peening.

Brittle fractures from deep sharp notches are not easily prevented by normal peening because the peening cannot reach the bottom of such notches where the stress multiplication is very great. When deep sharp notches occur during fabrication, they must be widened to permit peening or a small hole must be drilled at the end of the notch. The inside of the hole must then be peened by hammers designed for the purpose.

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Circuits and Applications

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Relays and contactors used as controlling devices combine efficiency with versatility. Depending upon the type of circuit, they may be used as linear or nonlinear amplifiers. In certain cases, their nonlinear characteristics give circuit performance which is unobtainable in linear systems.

Other significant features of contactor amplifiers and controls are their ruggedness and reliability, coupled with the opportunity they afford for circuit and equipment simplification, especially on control gear of highly complex design. Here, contactor amplifiers, when compared with tube types, may permit "engineering out" such components as filament transformers, circulating fans, and certain fail safe circuiting that duplicates existing elements.

The fundamental principles of linear and nonlinear contactor amplification, together with the characteristics of available relay devices were covered in "Contactor Amplifiers for Automatic Control", which appeared in the March issue of *Product Engineering*, page 186. The following discussion covers typical contactor control applications and circuits which have proved successful. Techniques are also included for the stabilization and interconnection of these systems.

Differential Actuated Relays

The circuit shown in (A) can be used to maintain exact synchronism between two rotating machines. The machines, which operate nominally at the same speed, drive the synchro generators. A differential motor, connected to the generators, takes a shaft position corresponding to the difference in generator shaft angles. When this difference exceeds some preassigned allowable limit, the moving contact on the differential shaft will contact one or the other of the fixed contacts (depending on error polarity). A control action will then be initiated to correct the error.

In (B) is shown a position control which operates on the same principle. A change in input shaft position will cause the differential motor to close the proper relay contact. The drive motor will be energized to bring the output shaft into angular alignment with the input shaft. Mechanical stops can be put on the differential shaft to avoid overstressing the contact springs.

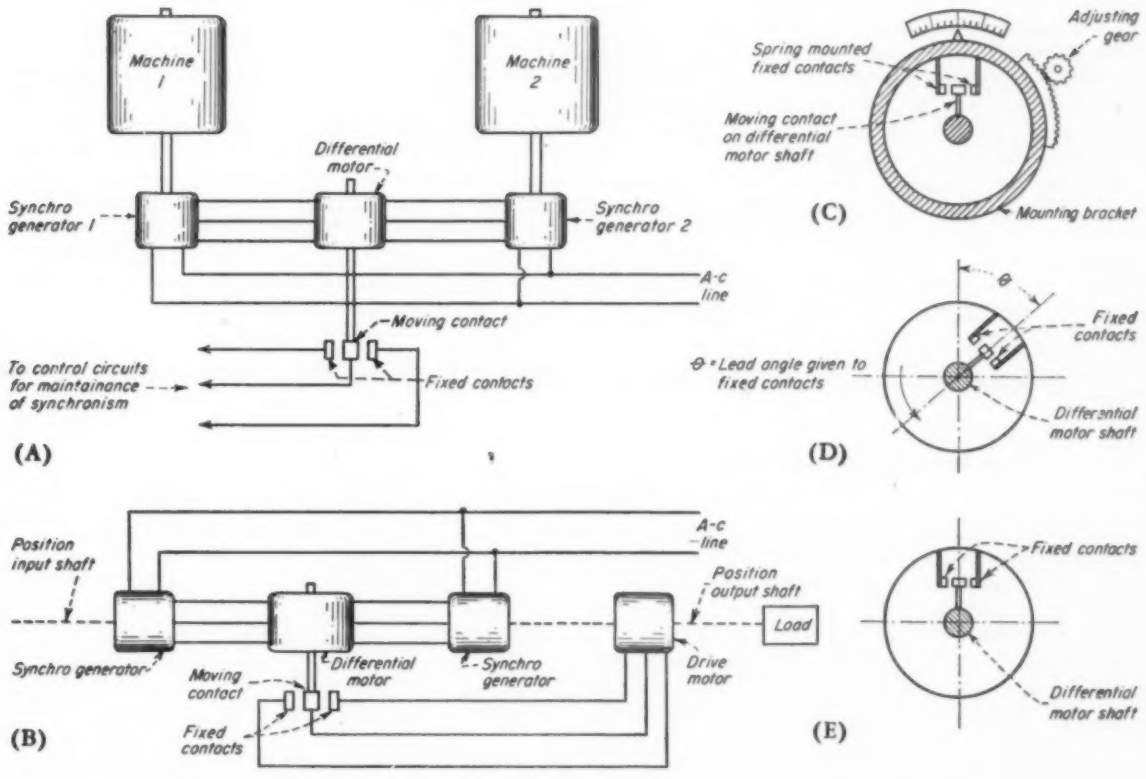
As a variation of these two systems, a mechanical differential can be used in place of the synchros where remote positioning is not required.

By using a differential (either mechanical or electrical) in this manner, the position of the fixed contacts can be made adjustable, (C). The relative position of the machine shafts can be varied by rotating the mounting bracket. This permits exact correspondence in position and gives maximum flexibility. This arrangement is useful when more than one motor is driving a load and close synchronism is required.

An unusual type of damping can be used. The position of the differential is a measure of the deviation from synchronism, or the error. The speed of the differential shaft is a measure of error rate. For best performance the differential shaft should come to its null position with zero velocity. This prevents overshoot and relay chatter. To obtain this the fixed contacts are given a displacement or lead which varies with the error rate. This causes the contact to close sooner than normal.

In (D), the differential is rotating in the direction

# of Contactor Control Devices



shown and the fixed contacts have been given a lead angle θ. The moving contact will touch the left hand fixed contact early, and a reversing torque (opposite to the indicated direction of shaft rotation) will be applied to slow down the differential. If the lead angle is the correct amount for the corresponding velocity of the differential shaft, the system will come to rest in the synchronized position (E) with no overshoot.

There are many ways of obtaining the lead angle. The fixed contact mounting bracket can be connected to a fixed frame by means of a spring. Then the rotating shaft is coupled to the mounting bracket by a friction clutch or an eddy current coupling. In the latter case, the lead angle is directly proportional to speed. This is ideal in a linear system, but in an on-off type servo it is more desirable to have a lead angle proportional to the square of the error rate since with a constant torque the distance to come to rest varies with the square of the speed. This is difficult to obtain mechanically, although several suitable electric circuits exist.

(*Continued on next page*)

Regulating Devices

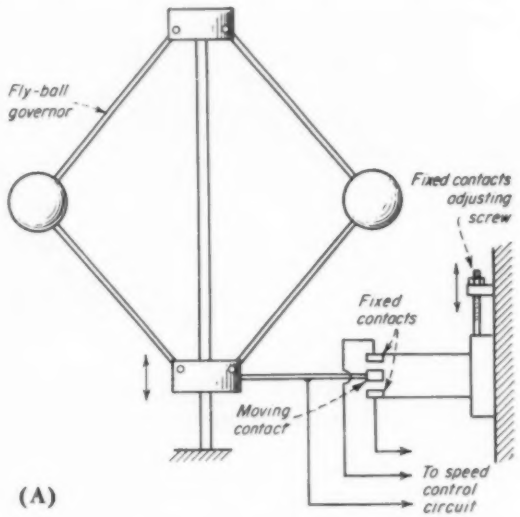
One of the most common applications of on-off relays is in the regulation of speed, voltage, temperature, and many other variables. The Watt steam engine governor, (A), has been widely used for speed control.

A single-ended speed regulator is shown in (B). At speeds above the allowable maximum, centrifugal force acting on the moving contact will cause the contacts to close. Slip rings connect the relay contacts to the external circuit, where they operate some controlling device to reduce speed. A single-ended device such as this only operates when the controlled variable tends of its own accord to rise above the required value. The only controlling force acts to reduce speed. Thus, the regulating action of the on-off controller maintains the speed just below maximum by closing the contact when the critical speed is reached.

To obtain firm contact pressure and reduce contact resistance and arcing, a snap action is incorporated in the spring supporting the moving contact. This causes a speed differential, (C), between contact tripping and release resulting in a continuous hunting between the limits of the differential.

Reducing the differential decreases the deviations or hunting, but increases the oscillation frequency and the force of the contact closing. This reduces the life of the regulating device.

The bimetallic thermostat, used for temperature control, is a device of this type. The action of the regulator is



(A)

to energize heating elements whenever the temperature falls below the preset limit. The temperature control unit is also single ended (unless a refrigeration plant is available to correct for a rise in temperature above an allowable value). A built-in snap action permits a reasonable amplitude of oscillation, (D), to assure long thermostat life.

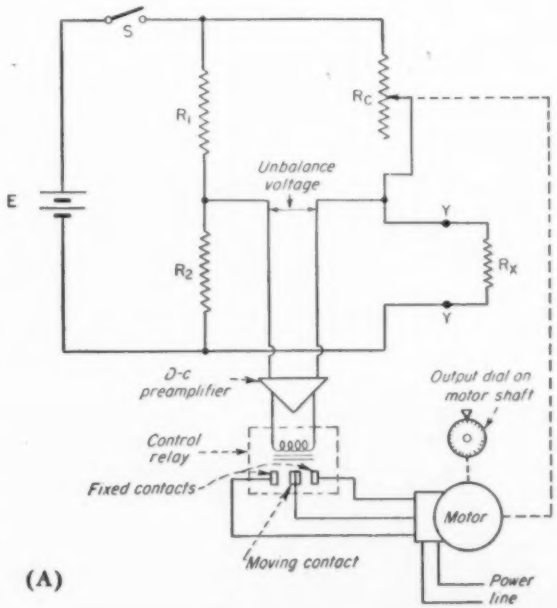
Another version of the on-off temperature regulator is the mercury contact device, (E). The temperature increase above the allowable limit causes the mercury to expand until an electrical contact is made.

Self-Balancing Bridges

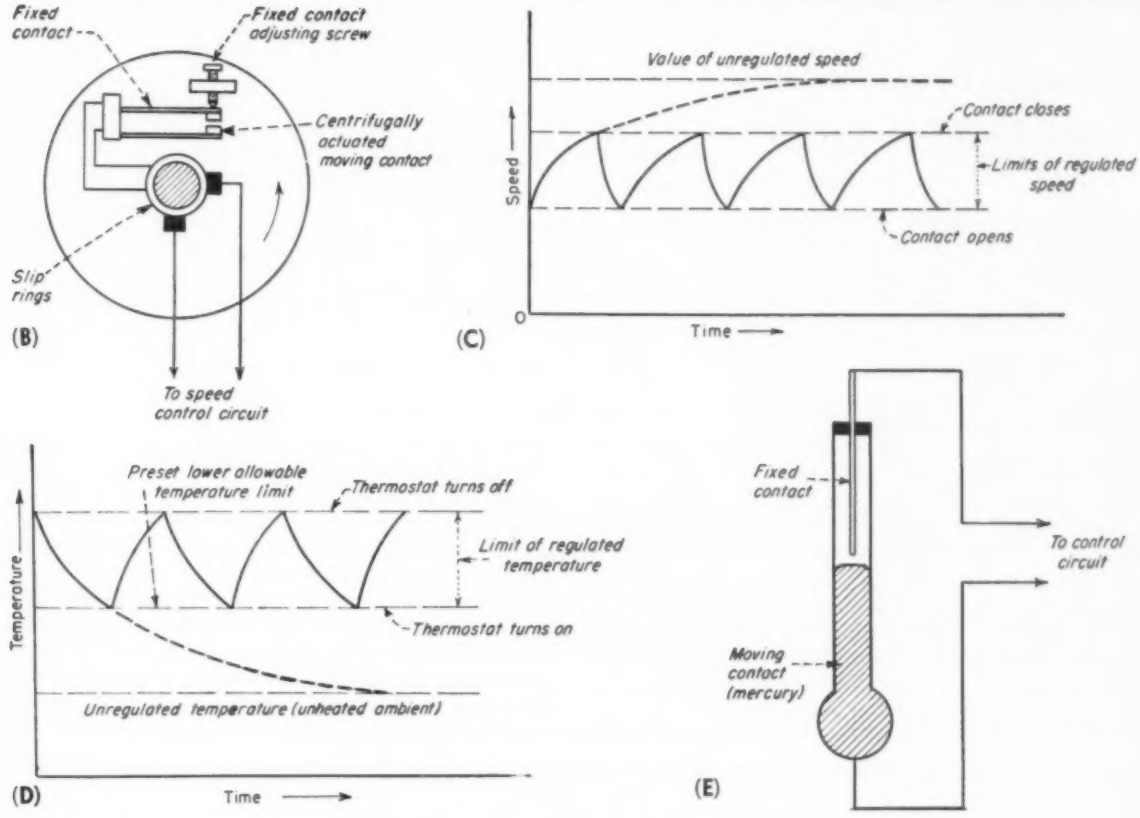
A resistance measuring bridge using a relay as the control element is shown in (A). To determine the resistance of R_x, the unknown resistor is connected to terminals *Y-Y*, of the bridge and the switch, *S*, closed. Any unbalance voltage is amplified and applied to the control relay. The motor is energized to vary R_c until the unbalance voltage is small and the condition R_1/R_2 equals R_c/R_x is obtained (R_x equals R_2/R_1 times R_c). When the balanced condition is reached, R_x can be read directly off the output dial to a high order of accuracy. This arrangement is fast acting and inexpensive. By the introduction of a demodulator into the null circuit it will operate on a-c.

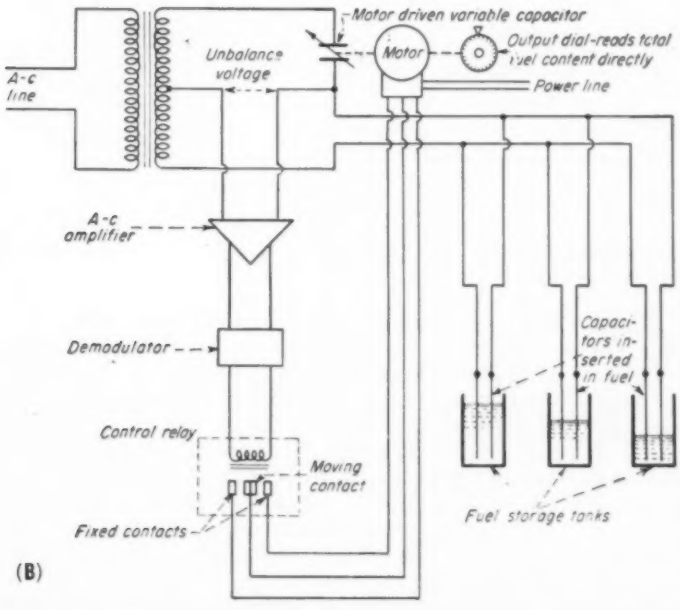
If the four resistors are made of materials having the same temperature coefficient of resistivity, operation over a wide temperature range will introduce no error. Variations in voltage, *E*, or frequency or wide changes in amplifier gain or relay sensitivity do not affect the accuracy of the instrument.

Circuits such as this can also be used for temperature



(A)





measurement. For this application, the resistor, R_x, is made of a temperature sensitive material, such as platinum or a nonlinear semiconductor. The continuous corrective action of the bridge permits continuous reading of the temperature on the output dial. The motor can also be used to drive the pen of a recording device.

A variation of this circuit can be used to measure the total liquid content of a number of tanks, (B). This circuit represents a fuel measuring instrument in an airplane. The rising fuel level changes the dielectric constant and therefore the capacitance of the tank condensers. Since the condensers are in parallel, their capacitances add and are balanced by the motor driven variable capacitor.

By means of appropriate transducers, and the use of a-c elements in the bridge arms, the self-balancing bridge can be used to measure pressure, displacement, fluid flow, and other variables.

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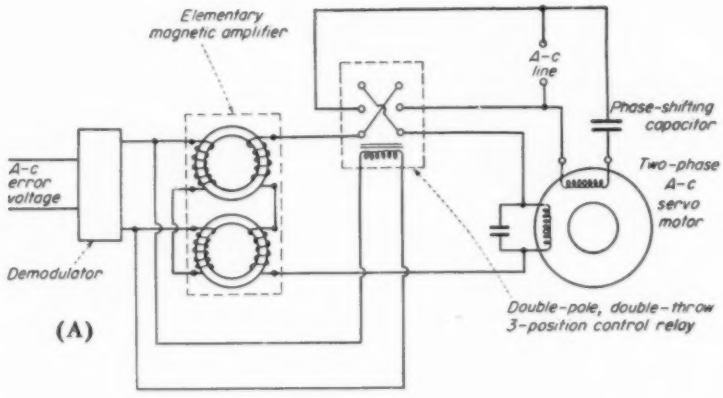
Relay Control of Single-Ended Components



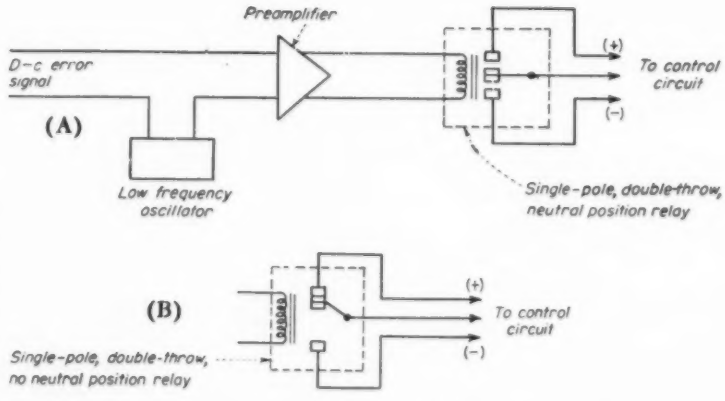
When the error exceeds the relay tripping voltage, the relay will close connecting the servo motor control coil to the output of the magnetic amplifier. This amplifier output is approximately proportional to the error magnitude, giving linear control. The relay reverses when the error polarity changes but operation will otherwise be quite smooth. Long life can be expected from this arrangement, in comparison with other methods where relay switching is more rapid.

Components which can supply linear or nonlinear corrective outputs, but not of reversible polarity, can be applied in feedback systems by using reversing relays. For example, single-ended magnetic amplifiers, (A), can supply a given amount of power with about one quarter of the magnetic core material required for the double-ended or push-pull amplifier. Thus the circuit is not only relatively inexpensive but consists entirely of components that can withstand severe operating conditions.

Damping can be introduced into this circuit by applying additional anticipation voltages directly to a separate relay coil. In this way an earlier relay reversal can be obtained, reversing the corrective action and preventing overshoot when the null is reached.

The clutch servo, (B), is a mechanical equivalent of the reversing relay. The main drive motor rotates continuously in one direction. With no error voltage applied to the clutches the gears idle and the output shaft does not rotate. When an error occurs, the output shaft will rotate one way

Proportional Control Relay Amplifiers



A continually oscillating relay can be used to obtain proportional control between input and output, (A). In this circuit the moving contact continually chatters because of the induced alternating signal. With no error voltage the relay will dwell equally on the positive and negative contacts, and the net corrective force will be zero. The application of an error voltage will cause the moving contact to favor one or the other of the fixed contacts, and a net corrective force will be applied. There are a number of other ways of obtaining this relay chatter.

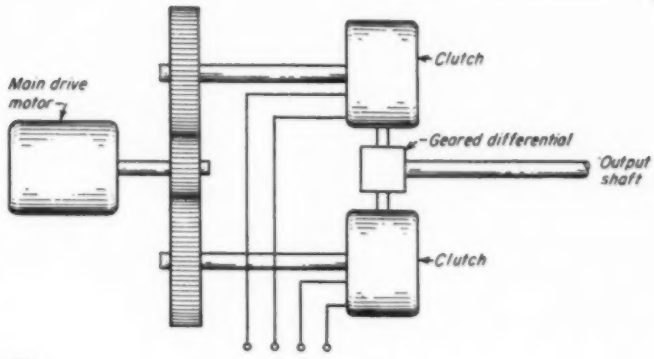
The use of a two-position relay with no neutral center, (B), will result in a continuous chatter. The same effect can be obtained with a relay having a neutral center by increasing the gain so high that instability occurs because of an overly small dead zone. However, relays without the neutral center position are cheaper.

With these circuits, the inertia servo load will accurately take the mean position with only a slight response to the dither. If further smoothing is required, filter circuits can be used to minimize the oscillating effect.

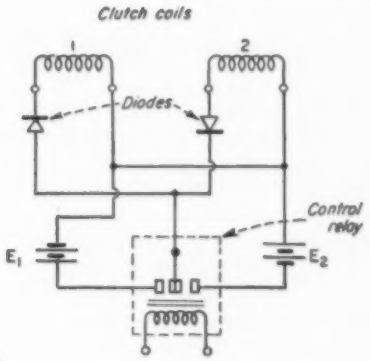
Dither can also be obtained by using a feedback circuit, (C), which introduces oscillation much as in conventional electrical and mechanical oscillators. The action is similar to that of a bell buzzer.

The motor capacitor is connected in series with one or the other motor windings, depending on which relay contact is closed. This in turn depends on the polarity of the error signal. The direction of motor rotation is therefore sensitive to error polarity, a required condition for feedback correction.

Ignoring the affects of feedback oscillation, this circuit



(B) Clutch excitation coils



(C) To control circuit

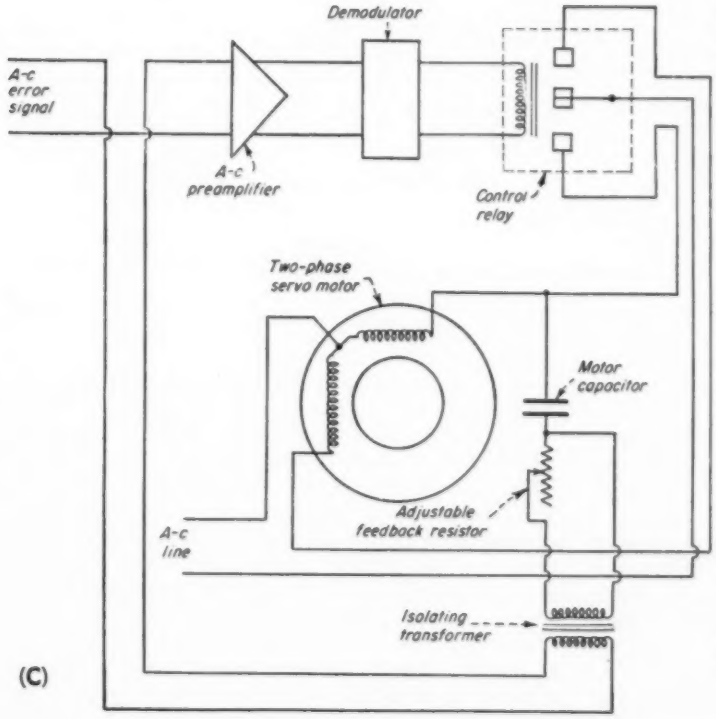
or the other depending on which clutch is energized. This supplies the polarity sensitivity, missing in the drive motor, but required for satisfactory feedback operation.

Since the clutches supply the polarity sensitivity, a cheap, high inertia, commercial motor can be used in place of the usual low inertia, high stall torque, high priced servo motor. Clutch servos operate rapidly and are frequently used to drive high inertia radar antennas.

The required clutch coil power varies from 1 percent to 10 percent of the power delivered to the load. Thus, small electronic amplifiers, magnetic amplifiers, or relays can be used to supply coil power.

A control relay circuit to supply clutch excitation is shown in (C). The d-c polarized relay closes one contact or the other depending on error polarity. The diodes in the coil leads are for polarity discrimination so that the proper clutch is energized to correspond with the error polarity.

On-off clutches can be analyzed in an identical manner to on-off relay servos, since both are characterized by the discontinuous application of full corrective action.

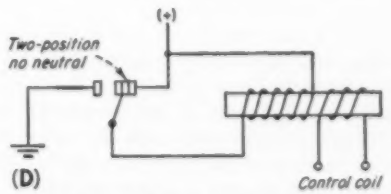


(C)

has two advantages: (1) a single-pole relay; and (2) no power to the motor when the relay is in its neutral position.

To introduce the aspect of proportional control, assume that the polarity of the fedback voltage is such that it tends to reopen the relay contacts. Thus, the a-c voltage drop across the feedback resistor has a polarity opposite to the input error voltage. This reduces the relay stickiness.

If the fedback voltage is large enough, the relay stickiness or hysteresis becomes effectively negative and a continuous chatter occurs if the relay goes outside the dead zone. This results in proportional control.



(D)

In (D) each time a contact makes, a magnetic force is generated in the armature which tends to break the contact and oscil-

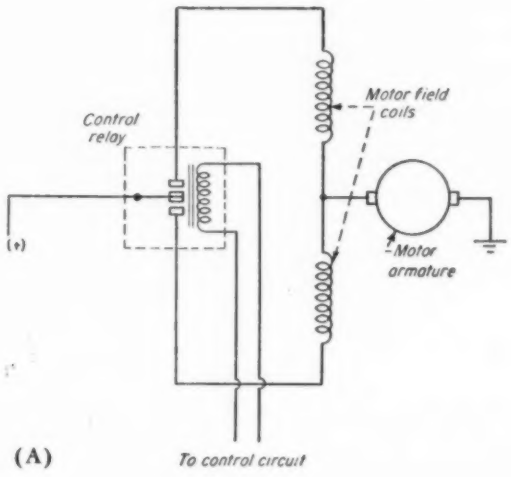
(Continued on next page)

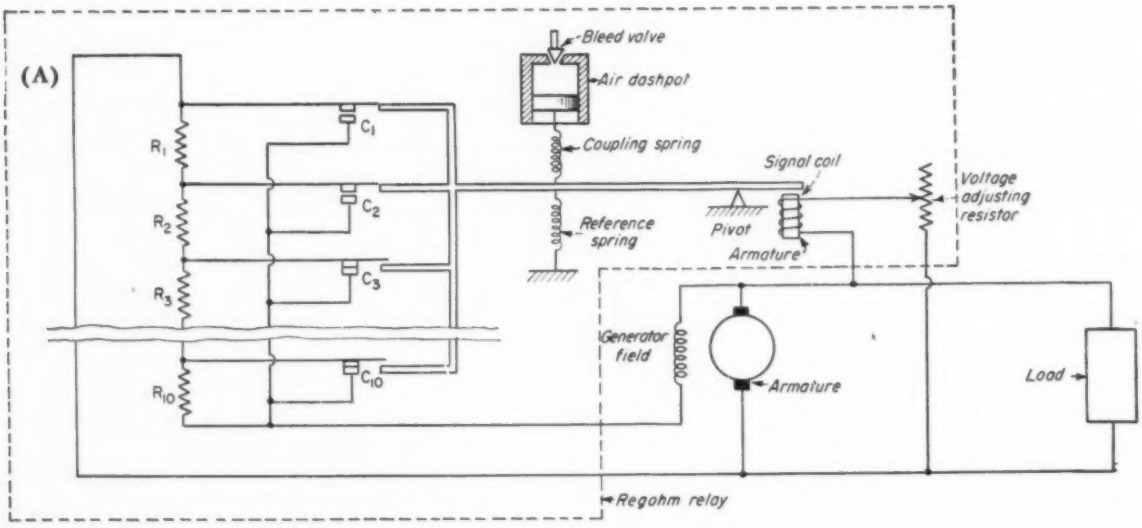
Motor Control Circuits

In (A) is shown a method of supplying field excitation to a reversible series d-c motor. The split series field permits the use of a single-pole, two-position control relay. This type of field causes reduced efficiency because of the number of turns which are required; however, the ease of control has made this a popular arrangement.

Since the control relay is in series with the armature, it must carry full motor current. With this arrangement, control sensitivity can be increased by using two relays in series. Thus, a light sensitive control relay, actuated by the error signal, will energize the power relay which must carry full motor current. A heavy tripping voltage can be applied to the power relay to give long contact life and overall increased sensitivity.

A three-phase motor control circuit with relay control of saturable reactors is shown in (B).





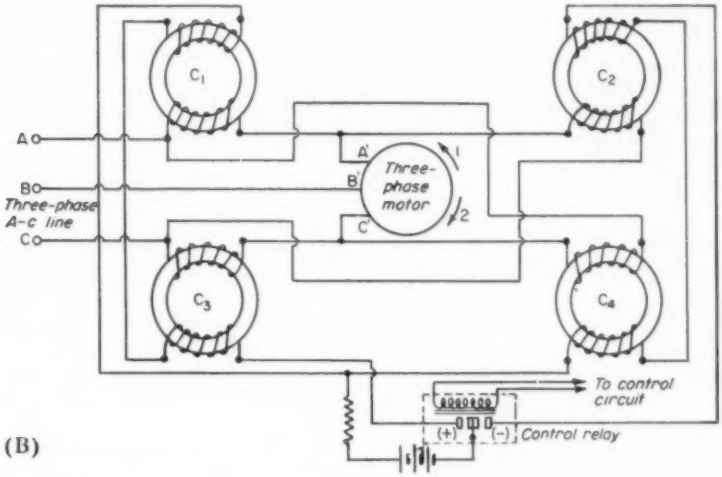
Multi-Fingered Relays

Relays such as the Silverstat, Westinghouse Electric Corp., and the Regohm, Electric Regulator Corp., give approximately linear control and are simple and compact. Resistors, which are in series with the load, are cut-out in a series of steps with each contact making or breaking only a fraction of the total volt-amperes. This arrangement gives smooth control and long relay life. The smoothness is improved by the dither or alternation of control between adjacent contacts which interpolates to get the "exact" required value. In (A) is shown a generator control circuit.

The regulated generator voltage is held constant by the action of the relay in introducing field resistance with rising output voltage. The dashpot and spring are similar to a tuned oscillation damper, but are adapted to the linear motion of the pivoted armature.

The armature does not respond until the current in the signal coil reaches a certain critical value. The voltage adjusting resistor is set so that this critical current corresponds with the required nominal line voltage. Variations about this value cause relatively large movements of the armature and wide corrective effects.

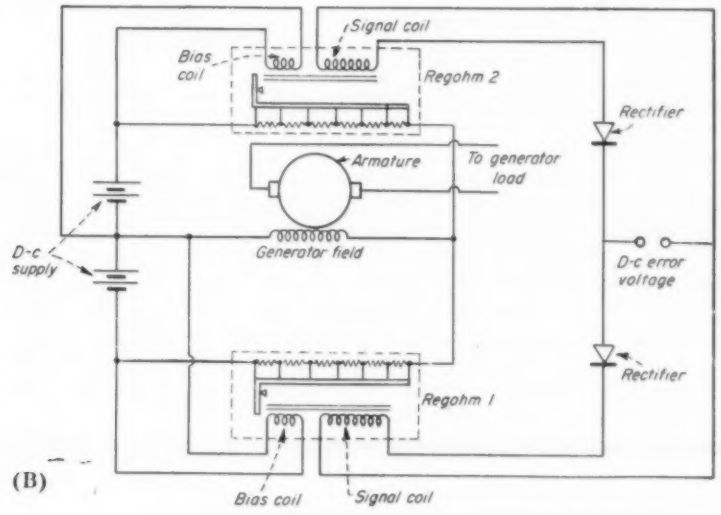
Two such relays can be used to control the field of a d-c generator, (B). (The relays contain the same elements as shown in the dotted box in (A).) The bias coils are



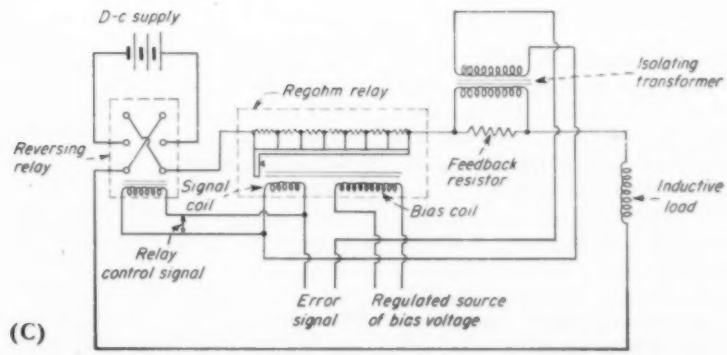
(B)

impede the flow of a-c when the d-c windings are not energized.

If the plus contact is closed, cores C_1 and C_3 will be saturated and cores C_2 and C_4 will be unsaturated. The saturated cores reduce the impedance of the connections from the A' and C' motor terminals directly to the corresponding line points, causing motor rotation in the 1 direction. Closing the minus contact saturates cores C_2 and C_4 and effectively connects the A' and C' motor terminals to the C and A line points, reversing motor rotation to direction 2. This method of control is characterized by high efficiency of power transfer.



(B)



(C)

energized at something under the critical signal value. A d-c error voltage will excite one signal coil or the other depending on polarity, the rectifiers preventing the simultaneous application of voltage to both coils. The bias voltage is normally regulated by a gas tube. If the d-c voltage is unbalanced by a variation of resistance in one of the relays, a current will flow in the field of the controlled generator.

If the voltage drop across a resistor in the generator field circuit is fed back to the input terminals (opposing error polarity) the time constant and gain will be reduced just as in a conventional amplifier.

A similar circuit using a multi-fingered relay and a reversing relay is shown in (C). The reversing relay is energized in accordance with signal polarity. The feedback arrangement increases the smoothness of control and reduces the time constant.

The finger type regulator can be used in many applications requiring the control of a variable about a specified nominal value. For example, it serves as a phase shifting element in thyratron circuits, as a power amplifier in closed loop servo systems, as a temperature control operating on the self-balancing bridge principle, and in a variety of other circuits.

(Continued on next page)

Damping and Stabilization Methods

A remote positioning system, (A), will oscillate or hunt if it is not properly stabilized or damped. Stickiness in the relay can cause oscillations by maintaining a corrective torque on the servo motor after the error has been brought within allowable limits. Instability is also caused by various time delays in the corrective circuit, such as inertial lag in the motor circuit and current lags in the inductive coils of the relay and motor. These delays cause the output shaft to overshoot and oscillate.

Several methods which can be used for stabilizing this circuit will be covered in the following discussion. These methods are general, and can be applied to other systems than the example shown.

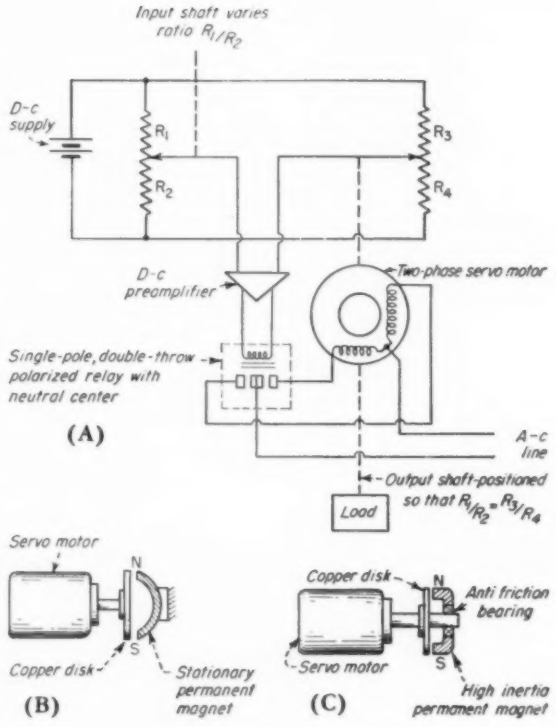
In eddy current damping, (B), energy is dissipated as eddy currents induced in the rotating copper disk by the permanent magnet. Induction motor type torques reduce the servo motor oscillations. The drag torque is directly proportional to speed. A friction disk can be substituted for the eddy current coupling, or where possible, viscous damping can be obtained by rotating a motor driven impeller in a viscous fluid.

This method has the disadvantage that motor power is wasted and maximum motor speed is reduced. In (C) is shown an improved design.

As the servo motor turns at a constant speed, the reaction torque of the eddy currents in the copper disk will bring the permanent magnet to the same speed. Under this condition there is no drag torque on the motor and no added losses. However, if the servo motor oscillates rapidly, the high inertia permanent magnet cannot follow and torques will be generated as in the preceding case where the magnet was stationary. To introduce more effective damping, the permanent magnet can also be connected to the motor shaft by means of a spring.

Another effective type of stabilization drag can be obtained by using coulomb friction; where the drag is independent of speed. A spring loaded oiled felt pad rubbing on one of the output surfaces will have this characteristic. Since this method is inefficient it is not used in control systems with more than 50 watts output.

An electrically controlled brake on the motor shaft, (D), can be used for damping contactor systems. This method is fast and accurate when the input is varying rapidly and reversing. When the error is too small to trip the relay,



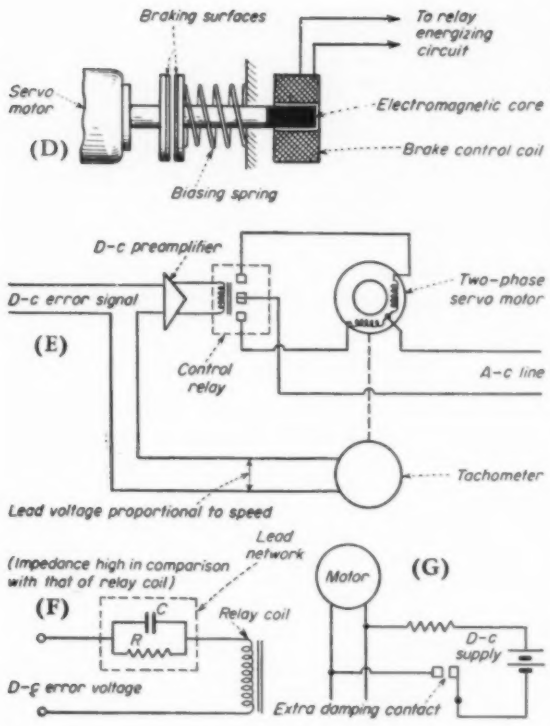
SYNTHETIC RUBBER MONOPOLY

Washington—When the Reconstruction Finance Corporation submitted their annual report to Congress last month, the representatives found in it an answer to the problem of how to get the government out of the synthetic rubber business. RFC's plan calls for the development of a disposal pattern that will permit free operation of competitive forces "by preventing domination and assuring a supply of rubber to those users who do not purchase facilities."

Valued at over $750,000,000, these facilities produced 746,551 long tons of rubber last year at a gross sales price of $416,500,000. Under RFC's plan, the government will sell the plants for about $350,000,000—a figure that industry agrees with.

Free enterprise operation may produce benefits for designers. Although the rubber industry is research minded, industry spokesmen claim that progress in synthetic rubber development has been slowed by government monopoly and the associated economic problems. Some rubber companies have already developed experimental materials which hold great promise. But they are reluctant to turn these over to the government monopoly or enter into competition with tax-free facilities.

For the present, RFC thinks that the synthetic rubber program in the United States is in good shape. They point out that production of synthetic has reached a point where it can survive competition with natural rubber in private hands. Congressional justification for government rubber has



the brake is engaged by means of the biasing spring. With larger errors, the relay trips and power is supplied to the motor with some being diverted to release the brake. This permits the motor to move. Under normal operation, every time the relay reverses a pulse of braking torque will be applied to the output shaft. This tends to stabilize the system. A motor approaching its null position at maximum speed should be stopped by the brake before it completely crosses the neutral position. This is the maximum synchronizing speed for a given size drive motor. Brake power requirements are only a fraction of the motor power.

In higher power systems, electrical damping methods, (E), are used instead of the bulky mechanical systems. In this circuit, a tachometer generates a voltage proportional to speed. The tachometer signal is in series with the error signal, but of opposing polarity. This causes the relay to reverse and apply braking torque before the null position is reached. Ideally the motor will slow down and come to rest at the null without overshoot.

Closed loop systems using relay amplifiers can often be stabilized by means of networks just as are conventional linear systems. In (F), under steady state conditions the current is limited primarily by the resistor, *R*, which also is a factor in setting gain or sensitivity. If the d-c error voltage suddenly increases the instantaneous current will be high since the transient is not blocked by the condenser, *C*. This initial high current speeds up the corrective action of the relay, giving the required anticipation or lead.

A-c lead networks are similar to the d-c variety with the exception that the condensers and inductors of the d-c circuit are replaced by high *Q* parallel and series resonant circuits. These are tuned to the a-c carrier frequency. Performance is good at the carrier frequency, but falls off rapidly if the frequency shifts by more than a few percent. Thus, the carrier frequency must be rigidly controlled.

Another type of damping which is well suited to contactor control circuits is shown in (G). The control relay has an extra normally closed contact to energize the damping circuit. When the error is within the dead space limits, this contact is closed and d-c flows in the motor winding. This current flow creates a strong damping force because of the eddy currents induced in the rotor. When the error is large enough to trip the control relay the flow of d-c is interrupted.

The effect of the d-c is to saturate the motor and reduce the available corrective torque. This helps when the relay is open since it stops the motor while the relay is in the dead zone and prevents overshoot.

been the resolve that the U. S. would never again be caught without an adequate supply of rubber, as happened at the beginning of World War II.

In the package that RFC wants to sell are 28 facilities—13 copolymer plants, two butyl plants, 10 butadiene plants, one styrene plant, one chemical plant, and one development laboratory. Probable customers are the rubber, chemical, and petroleum companies currently operating the installations for the government.

Previous legislation requires that President Eisenhower submit a disposal plan to Congress by April 15 of this year. The lawmaker's deadline for action is March 31, 1954 when present legislation expires. If this session can pass a disposal bill, negotiations could be carried on next fall, and Congress could approve the sale by next year's deadline.

RFC's plant disposal program, which experts say seems to be fair to both government and industry, includes these suggestions:

1. Buyers submit bids before a specified date. Then a government agency designated by Congress would negotiate with the bidders. This agency would be guided by a dual objective: to realize a fair price and to provide effective competition.

2. The Attorney General and the Federal Trade Commission would check monopoly violations.

3. No sale would be final until Congress gives it official approval. The government would place unsold plants on a standby basis.

4. Terms of payment—20 percent down and the balance on a 10 year mortgage.

Also interested in this plan are those companies currently working for the Atomic Energy Commission. Many experts feel that RFC's rubber disposal program will set a pattern that AEC will follow when it comes time to sell atomic installations.

Using SR-4 Gages to Measure Strains in Wire Strand

A. SMISLOVA
A. C. LOEWER, JR.
W. J. ENEY
Lehigh University

Using the data from strain gages mounted on individual wires, the designer can accurately predict what values of the elastic properties can be expected from the strand as a whole.

A SATISFACTORY TECHNIQUE for measuring stresses in the individual wires of small steel strand with SR-4 strain gages has recently been developed. It was a result of a test program on pretensioned, prestressed concrete beams. The strand, which served as a reinforcing member, was 0.308 in. in diameter and consisted of six 0.10 in. wires twisted around a central wire of 0.108 in. diameter.

For a complete interpretation of the test results accurate measurements had to be made of the prestressing force, the creep, the reduction of stress due to the volumetric change of the concrete, and the behavior of the strand during release of initial tension as well as during the application of the live load. A preliminary study investigated the practicability of crimping a small metallic tube on the strand and then applying SR-4 gages on the tube. This proved to be unsatisfactory because of the inability of the tube and strand to act as a unit.

With the new technique a portion of the strand was swaged so that the width of each wire was increased to $\pm\frac{1}{8}$ inch without any loss in ultimate strength of the strand. Type A-12, SR-4 gages were chosen because they provided (1) sufficient length to enable accurate orientation of the grid of the gage along the longitudinal helical surface presented by each wire; (2) a narrow width so that the complete grid could be located on only one wire.

To establish the reliability of this procedure, a seven-foot length of strand containing standard leaded end fittings was swaged in three places, viz. at the mid-length and near each end. After the swaged areas were thoroughly cleaned and roughened with emery paper, four A-12 gages were mounted with a cellulose acetate cement. One gage was located at each end and two were placed in the mid-length swaged portion. One of the end gages was placed on the same wire that contained one of the gages on the mid-length swaged portion. The other gage located at the mid-length was placed on a diametrically opposite wire. All gages were cured for 12 hours at 120 F before testing.

Load was applied to the seven-foot length of strand, by a 300,000 lb. hydraulic testing machine. Strains were recorded over four cycles of loading. The loading operation consisted of loading the strand to 124,500 psi, releasing to 17,750 psi, repeating for two more cycles, and then loading to failure.

The results of the recorded strains for the four load cycles are shown in Fig. 1. Gage No. 1, located at the mid-length of the strand, had an identical load and unload curve for the first three cycles. Gage No. 3, also located at the mid-length of the strand, exhibited the same characteristic, although it produced a curve slightly different than that of gage No. 1. Gage No. 2, located at one end of the strand and mounted on the same wire as No. 3, produced slightly different load and unload curves for the first cycle of loading. However, the load and unload curves of gage No. 2 for cycles 2 and 3, follow identically the unload curve of the first cycle. Gage No. 4 was damaged in the process of readying the strand for test. For load cycles 2, 3, and 4, all gages yielded very nearly the same modulus of elasticity, the average value of which is 28,100,000 psi. This value is for a single wire of the strand. The manufacturer's figure for the whole strand is 28,500,000 psi. By comparing these two values, it was concluded that the modulus of elasticity for a strand of this type can be determined with a satisfactory degree of accuracy by using Hooke's Law on one of the wires which makes up the strand.

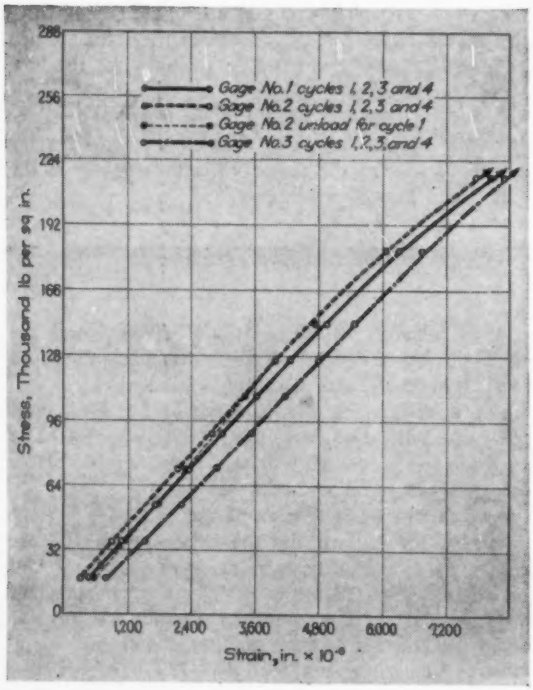
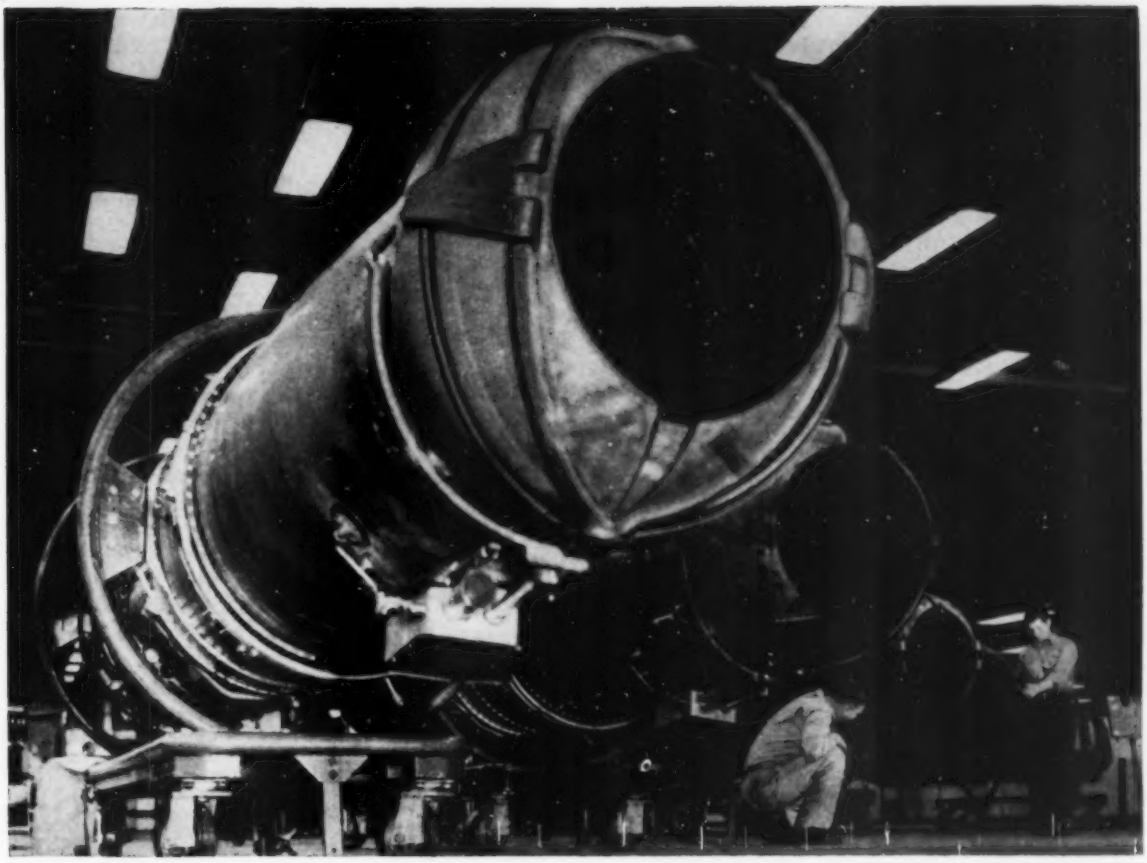


Fig. 1—Stress-strain curve for four gages and four load cycles. Load for cycles 1, 2 and 3 was 124,500 psi. Strand was loaded to failure for the last cycle.

The cooperation of Messrs. K. Preston, H. Godfrey and I. N. Hicks of the John A. Roebling's Sons Company is gratefully acknowledged.

TECHNICAL NEWS



AFTERBURNERS being checked after jet engine assembly in General Electric's Lockland, Ohio, plant. With the same static thrust as a larger, heavier engine without the reheat device, afterburner equipped plane will have twice the rate of climb.

AFTERBURNER DESIGN PAYS OFF

ADDITIONAL THRUST needed to zoom jet interceptors to 40,000 ft and give fighters lightning-like getaway presented several big design hurdles before Ryan Aeronautical Company engineers came up with what they claim as the first successfully developed afterburner.

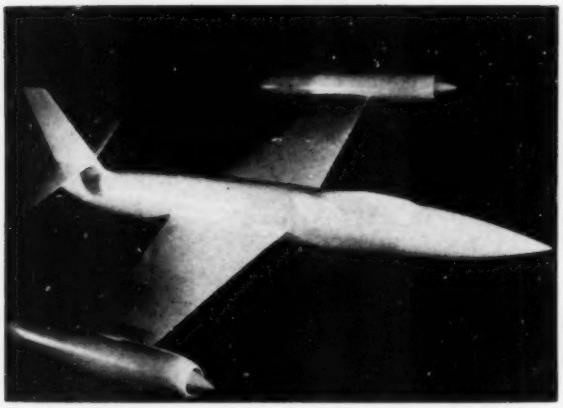
Essentially a ram-jet engine hooked to the tail of a turbojet, an afterburner looks like an easy way to get large thrust dividends from a jet engine. Actually, three tough problems had to be overcome:

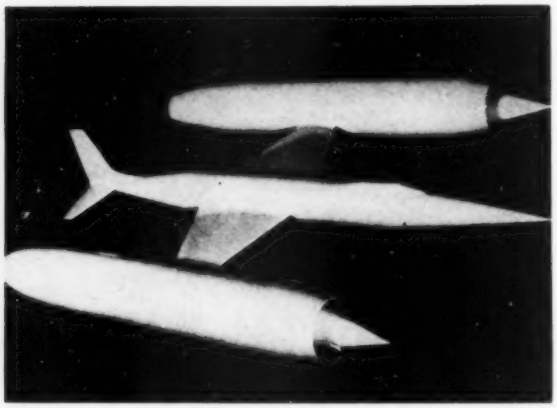
- How to ignite the afterburner flames.
- How to keep the flames going and confined within the afterburner.
- How to control the soaring flame temperatures.

Contrary to expectations, it was found that fuel injected into the hot afterburner did not ignite spontaneously because of the tremendous velocity of the gases. Igniter plugs are needed to spark the combustion.

The flame propagation rate of the fuel burned in the afterburner is about 340 mph. To maintain combustion, regions of low-velocity gas and turbulence are created by installing a flameholder in the duct. In some designs, engineers went to a diverging cross-sectional pipe so that the gases can expand thereby losing speed. Then, in order to maintain a balanced jet stream mass flow through the system, an "eyelid" arrangement was incorporated to vary the exact opening. This insures maximum thrust commensurate with temperature and pressure limitations. It prevents excessive back pressure and internal temperature rise if the exit opening is too small, or decrease in jet stream velocity and drop in thrust when opening is too large.

Controlling temperature was another engineering enigma. With flame temperatures running to 3,200 F, some means had to be found to lower the afterburner metal temperature below 2,723 F, the melting point of the cobalt and nickel-base alloys used in the construction. Actually, the entire jet engine including tail cone and afterburner assembly is kept within tolerable limits by a boundary of air flowing close to the inner surfaces. The cooling air flows between the in-





JET MODELS fabricated by NACA labs for hypothetical flight at 1,350 mph show relative size of power plants to give needed thrust. Smaller nacelles house afterburner-equipped turbo jet engines. It is claimed that without these thrust-augmenting devices, unwieldly size of turbojet engines would render supersonic speed designs worthless, slowing-up aviation progress.

ner and outer combustion chambers keeping the metal down below 2,000 F. Since the hot central exhaust gas travels approximately 560 mph, the cooling air hugs the surface of the metal walls and does not mix with the exhaust blast. Entire fluid stream goes into the afterburner where additional quantities of fuel are burned with it. Here, soaring temperatures are again insulated from walls by the boundary layer cooling air. Key elements such as turbine wheel bearings are cooled by air piped individually to these locations. It is interesting to note that "cooling air" starts out at 450-500 F and ends up at about 1,000 F. Compared to the 3,200 F plus flame temperatures, the air is a positive cooling agent which prevents the afterburner from becoming a fused mass of metal.

Ryan is now testing an idea having the fuel for afterburning introduced ahead of the turbo jet turbine wheel instead of after it. Thus, the turbine wheel acts as a flameholder and turbine nozzles as atomizer, breaking up the fuel. Because of natural ignition delay, this design would prevent increased turbine wheel temperature. By permitting a shorter tailpipe, afterburner's adaptation to aircraft with swept-back wings could be accelerated.

COLLEGE FINANCING AIDED

Greater support of technical education by industry has been urged by Product Engineering. More of both scholarships and grants to universities are needed. The formation of the group described below is a significant step towards helping colleges out of their financial plight, reducing their dependence on government subsidies.

FINANCING, the number one problem of U. S. colleges and universities, will get industry help from a new corporation formed by leading business men. Called the Council for Financial Aid to Education, the non-profit group will advise business organizations and colleges on programs for the latter's financial support.

In the past ten years inflationary costs have drained college resources. The situation has become so severe that many institutions are in danger of political domination (*Product Engineering, March* 1952, p. 117) because they must accept more of their funds from federal and state governments.

Some schools have banded together on a regional basis to seek financial help from industry. But results have not been too encouraging. The new council plans to furnish leadership and encouragement for these and other academic groups.

Industry members of CFAE include Frank W. Abrams, Chairman of the Standard Oil Company of New Jersey; Irving Olds, former Chairman of the United States Steel Corporation; Alfred P. Sloan, Jr., Chairman of the General Motors Corporation; Walter Paepcke, Chairman of the Container Corporation of America; and Henning A. Prentis, Jr., Chairman of the Armstrong Cork Company.

According to Mr. Abrams, who acted as spokesman for the group, CFAE plans to operate on a three-year basis. They expect to obtain funds for operation from philanthropies like the Ford, Sloane, Rockefeller and Carnegie Foundations.

Abrams said that as a main objective the new group will try "to promote a better understanding by the managers and owners of American business of the substantial contribution which higher education has made and is making to the growth and success of American industry."

Behind this new organization is the realization by industry management that today's complex operations require an increasing number of college trained people with a diversity of talents and training. As a result, business men now believe that industry should support education because of its need and not just because tax laws permit corporations to deduct charitable contributions (up to five percent of their taxable income).

Since laws permitted such deductions, industry has contributed about $235,000,000 for higher education. But if colleges are to retain reasonable tuitions, business must increase its support.

PROP REVERSAL EXPLAINED

BECAUSE OF A SERIES OF FATAL ACCIDENTS attributable to unwanted propeller reversing, the Civil Aeronautics Administration delved into the problem and came up with possible causes and recommendations to prevent further crashes.

Causes usually lie in two areas: (1) electrical faults in the propeller control system; (2) inadvertent movement of the throttle into reverse flight.

Here are several possible electrical trouble spots.

• *Terminals.* Most vulnerable parts are terminals and connectors. At many terminal points, bare metal parts of the reversing circuit are exposed to possible contact in case of loose connections.

• *Connectors.* Multiple connector plug is another point of vulnerability, especially where the wires are soldered to the connector pins at the back of the plug.

• *Wiring.* Deterioration of insulation occurs due to heat, improper handling, exposure to elements and chafing at various supports.

To prevent undesired reversing signals resulting from electrical system faults, CAA reports recommend entirely separate terminal points for reversing circuit, elimination or use of separate connectors, and routing vulnerable wires away from all other energized circuits.

Second type of problem encountered with reversing propellers is accidental movement of the throttle levers back into the reverse position. Moving the throttle into reverse, accidentally or deliberately, has same result—propeller reversal. Here are several safety features to remove the accidental possibility.

• *Throttle lock.* Lock is closed during flight and retracts when drawn to the open position as a result of closure of a switch on the landing gear. This switch opens the lock when the airplane is on the ground but with lock in place and adjusted, the pilot cannot pull the throttle in reverse.

• *Throttle lock over-ride and warning.* Should the lock fail to operate as intended, manual operation is provided through a linkage. Manual override of the lock alerts the crew to be very cautious retarding throttle.

• *Distinctive throttle motion.* Three devices are used to limit natural movement of the throttle. First is a spring loaded detent to provide an indication of the forward idle position. Greater force is required to move past the point. Second design has the throttle made in two sections, one sliding along the axis of the other. To move the throttle further aft, it must be lifted to pass over a stop. A cam prevents lifting the throttle at any point ahead of forward idle position. Third throttle arrangement does not use primary throttle levers to actuate propeller reversing. To reverse, the pilot must move a set of auxiliary levers, but these levers can only be operated when primary throttle is in idle position.

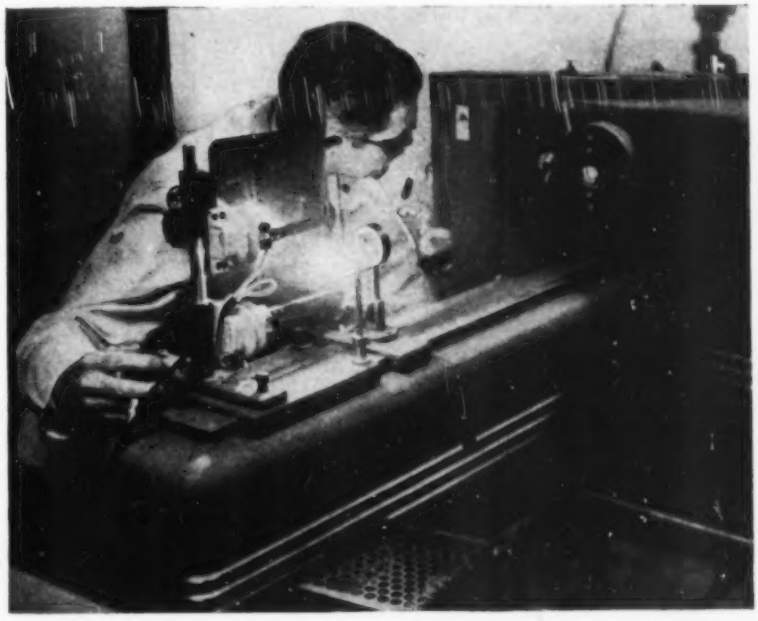
Another method receiving attention is a duplicate reversing control in series with present control. Such a control requires a separate means of actuation. Reverse pitch indicators are associated with reversing propellers.

OPTICAL ANALYSIS

NEW ADVANCES in the study of atomic structure, and speedy identification and quantitative measurement of substances present in the proportion of one part per million or less are made possible through the use of an instrument embodying a new concept in optics. Claimed to the third major advance in spectrum optics, the Littrow-Echelle Spectrograph is a development of Bausch and Lomb Optical Co., Rochester, N. Y.

Heart of the new concept is the echelle: an inch-thick, optically flat glass plate, three inches by five inches, having 200 ground grooves to the inch. Dispersive power is at least ten times greater than that of a diffraction grating. Resolving power is practically tripled. In the instrument, the echelle is used with a prism so that the prism spreads out the spectrum horizontally and the echelle spreads it out vertically. Produced is a two-dimensional spectrogram of greatly increased value in identifying and measuring.

Main use for the instrument is by research or industrial physicists and chemists. Typical quantitative application is the analysis for boron in steel.



OPERATING THE NEW BAUSCH AND LOMB SPECTROGRAPH. Light emitted from burning sample is directed into instrument where its spectrum is dispersed in two-dimensions and recorded photographically. Closest performing instrument in use is grating spectrograph which is custom made and built into special rooms. Echelle spectograph fits on standard 8 by 4 ft table and can be quantity produced

PUNCHED CARDS OPERATE NEW

EVER SINCE THE GRAPHIC ARTS INDUSTRY discovered photo offset printing in 1935, publishers and printers have wanted an accompanying photographic method of setting type. All the typesetter manufacturers have tried to provide such equipment. Their usual approach: redesign a standard typesetting machine and replace the lead casting process with a photographic technique.

Some of these machines are in production today. Others only reached the design model stage. Printers felt that these machines still did not offer all the potential advantages of photo typography. One machine, Photon developed by Graphic Arts Research Foundation, Inc., has recently set the type for a full length book.

Now the Phototypograph Corporation of New York has designed a machine based on experience derived from building electronic business machines rather than conventional typesetters. Using a basic design developed by consulting engineer Jack Drillick, Phototypograph's machine will set type from punched cards instead of keys struck by a skilled operator.

Here's how the process will work. A relatively unskilled operator, using a combination card puncher and electric typewriter, prepares the copy. The typewritten version goes to the proofing desk where it can be checked for typographical errors; the cards, with one line of type on each card goes to the photo composing machine.

Incorporated in the card punch is a collection of telephone-type, electromechanical stepping switches and relays that signal the operator when to end the line. This automatically spaces and justifies the copy.

In the photo composing machine, similar relays operate a series of shutter disks to permit photographing the proper letter at the correct time. To assure optical alignment at all times, the roll of film is moved by other electro-magnetic switches and relays so that the reproduced letter always hits the film at the same place.

Processing of type starts with developing the film. An artist strips in the negative in the same manner that photographs are presently fitted into offset layouts. Finally these negatives are used to make a plate, for the press, from which the final copy is printed.

Printers see many advantages to this type of machine. From an artistic standpoint, they will be able to reproduce much finer and more intricate letters even when type sizes are very small. Now they are limited by the thickness of line they can cast in lead.

Economically the machine may permit considerable cost cutting. Because the type is set by punched cards instead of an operator, the photo composer will work at top speeds all the time. This means a rate of 10 characters a second compared to the seven

JUSTIFICATION MECHANISM

1. Operator types copy and sets width of line on indicator. At same time he makes character selection for operating card punch and turns out typewritten copy for proofing

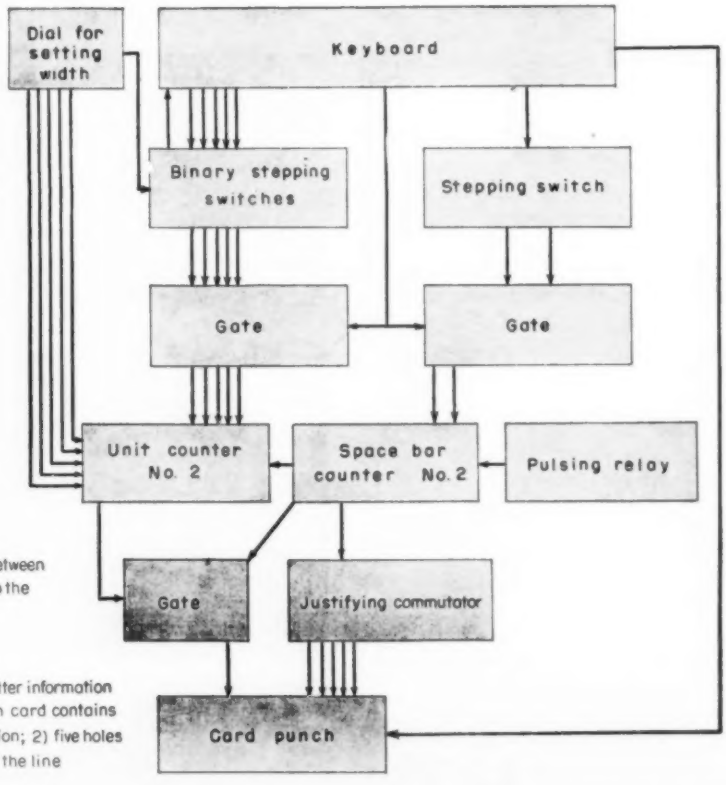
2. Stepping switch counts number of spaces between words. Binary switches total number of space units used by letters and signals operator when to end line

3. Gates are opened by the operator when he reaches end of line, passing information to other counters and clearing line 2 for new copy

4. Counts are transferred through the gates to secondary counters. Pulsing relay adds spaces to fill out the line to the specified width

5. Justifying commutator collects proper spacing between words to fill out line and passes this information into the card punch

6. Card punch is actuated by keyboard to produce letter information and by justifying commutator to supply spacing. Each card contains this information: 1) six holes control character selection; 2) five holes control spacing; and 3) one hole indicates the end of the line



PHOTOGRAPHIC TYPESETTER

a good linotype operator can set. Consultant Drillick feels that refinements in design may boost this rate to 12 or 15 characters per second.

Also it will permit a larger selection of type faces since the printer can change the font of type in seconds. Too, Drillick estimates that an optical font will cost only one fifth that of a lead casting matrix. That's because the optical type is photographed on glass, while the lead matrix must be machined out of brass.

Phototypograph expects the new machine to set type wherever photo offset printing is used. They doubt if it will replace lead type in newspaper operations because of the time required for photographic processes. However, magazine and book publishers with more available preparation time, will also probably find it economical to use.

The company is currently building a prototype which they expect to finish by 1955. They hope to be in production of these machines and ready to market them to the industry by 1958.

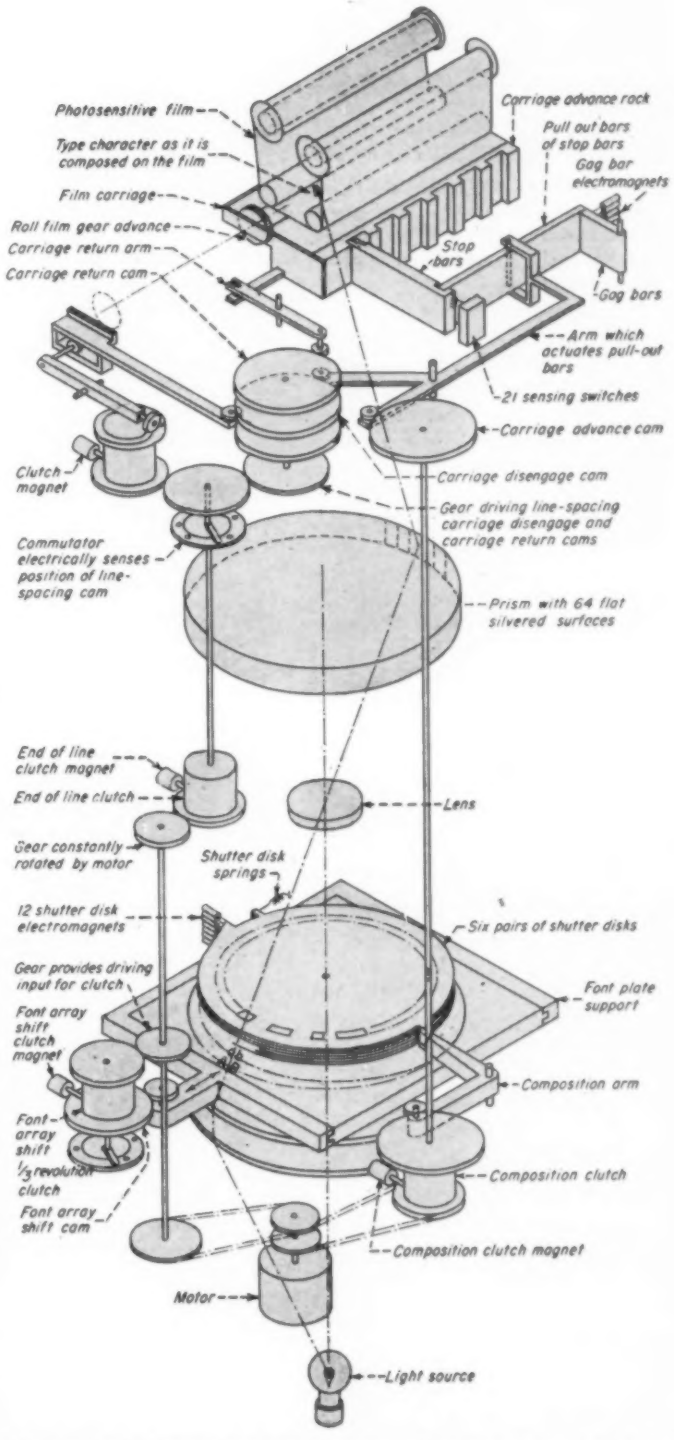


PHOTO COMPOSER (right). Heart of this device is the circular prism with 64 flat silvered surfaces that reflect type characters from the font plate to the photographic film.

Mechanical linkages perform three functions: 1) character composition which includes character selection, exposure onto film, and movement of film for proper spacing. The composition clutch activates this sequence. 2) Movement of film carriage and film at the end of a line by the end of line clutch and mechanism. 3) Shifting the font plate to any one of three circular arrays of type characters that are on each plate. Tripping the font shift clutch accomplishes this function.

To obtain smooth movement, all motions are cam-controlled. Electromagnets only set up functions so that action is quick.

Six pairs of shutters, each with a different variety of many sized slots, control character selection. To pick the proper letter on the font plate which contains 160 characters, the shutter disks are moved a few degrees so that aligned holes through the disk are opposite the chosen character. This is done after relays actuated by punch card information remove the stops in the shutter path. The composition clutch acting through the composition arm allows the disks to move under spring tension when the stops have been removed.

The film carriage is also spring loaded. It is moved for proper spacing during typesetting by the gag bar electromagnets. The carriage moves in increments of 0.010 in. Sensing switches determine where the carriage is at all times. To obtain the proper movement, punch card information moves through control relays (not shown) to the gag bar electromagnets that move the stop bars to permit proper spacings, taking less space than current typesetters.

One 1/10 hp motor supplies driving power for all the cams. The completed unit will be 20 x 24 x 36 in. in size.

INDUSTRY SHARES ATOMIC ENERGY

THOUGH STILL SOME YEARS AWAY, application of atomic energy in the metalworking industries points up significant uses in the industrial inspection and control fields, the Council for Technological Advancement stated in its recent report. Private industry's interest in atomic energy can generally be broken down into two areas: (1) electric power from heat of nuclear reactions; and (2) industrial applications of radioisotopes.

Radioisotopes are now being used in the application of tracer techniques in the measurement of wear in cutting tools, and the amount of wear in engines using different lubricants. A recently announced use is to measure impurities in processing germanium for transistor application. For the future: automatic control of chemical, metallurgical and other processes.

Fission products (radioactive by-products) are potentially earmarked by their low cost, availability and different energy levels obtainable in comparison with present sources. Future applications point to industrial photography, phosphor activation and cold sterilization. Big potential field is in the nondestructive testing of materials.

TRUCKERS ASK NEW REEFER DESIGNS

A PANEL OF EXPERTS from government and civilian trucking operations met during the annual meeting of Truck-Trailer Manufacturer's Association to offer suggestions for improving truck designs.

Operators' chief complaints concerned the design of refrigerated trucks and trailers, the so-called reefers. Typical feeling: insulation practices are arbitrary and out of date. One trucker asserted that the "six-inch insulation frequently used in reefer trucks is an absolutely arbitrary yardstick." "And experience calls for improvement in the installation of such materials," he added, "especially for long haul trucking."

He based his observation on the fact that insulation installed in vertical slabs between the body frame members often leaves room for air spaces and consequent temperature loss. His suggestion: install insulation in three layers, each layer at a 90 deg angle from the other.

Another complaint concerned the manner in which meat rails are attached to the truck body. Operators claim that present techniques introduce a weakening factor. They feel that the rails should be installed in such a manner as to strengthen the body.

Also listed were complaints against the use of certain materials. For instance, the truckers reported that aluminum was not proving satisfactory as a liner. They suggested that the manufacturers try some kind of plastic instead. Also magnesium floors that work well as weight savers corrode too easily when transporting items like fresh meat. At the same time, wood floors have not been satisfactory either. The truckers called for the development of new materials that would have longer service life on the inside of truck bodies.

RCA POINTS OUT DESIGN PITFALLS

MANUFACTURERS OF ELECTRONIC EQUIPMENT should heed the advice of the Radio-Television Manufacturers Association and work more closely with tube makers to avoid equipment failures stemming from circuits requiring electron tubes selected within close limits, is urged by RCA Victor's Tube Department.

RTMA emphasizes the importance of designing electronic equipment to function with tubes whose characteristics may fall anywhere within the entire range normal to tube type. Manufacturers who design equipment around "close-limit" tubes discover that a large number of tubes of the same type designation operate poorly or not at all in the equipment.

The answer to the problem lies in a three-point program: (1) equipment designers should work closely with tube engineers in the earliest stages of equipment design; (2) before designs are finalized the designer should explore all possibilities with tube-maker's engineers to assure the best choice of available tube types; (3) If available types are not satisfactory the tube maker may be able to recommend circuit modifications or the design of a new tube type.

HEAVY PRESS PARTS

NOW THAT THE U. S. HEAVY PRESS PROGRAM (*Product Engineering*, December 1952, p. 123) is well underway, fabricators are busy solving some of the vexing problems inherent with production. Number one headache: materials handling.

Since many of the parts will vie for the title of "world's largest", the people making the parts have to develop new ideas for moving these from one station to the next. Illustrating what's involved is this story from the Bethlehem Steel Company.

Bethlehem is converting 275 ton steel ingots into rectangular columns for the 50,000 ton Loewy Press to be installed at North Grafton, Mass. In all, 18 of these 110 ft columns are required.

Before forging could be started the company had to devise methods for moving both the ingots and the finished forging. For example, Bethlehem's engineers:

1) Devised a specially rigged railroad car to move the ingot to the forge shop.

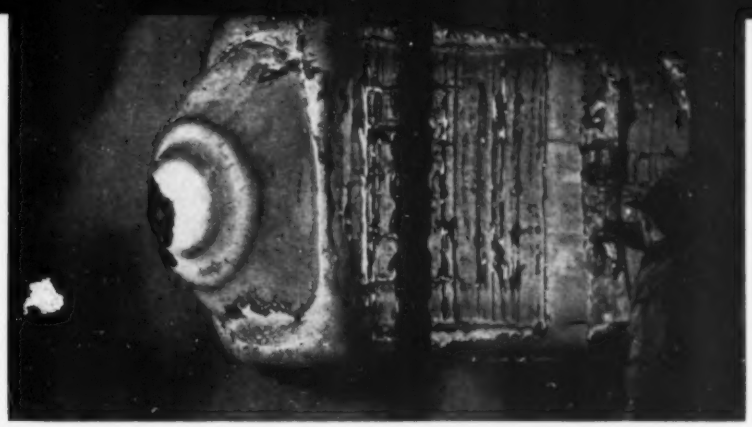
2) Developed special equipment so that two cranes of 200 ton and 125 ton capacity could carry the forging from the heating furnace to the forge when it had elongated to 40 or 50 feet. Supports at regular intervals distribute the load evenly and prevent the partially finished column from distorting out of shape while in plastic condition.

3) Rigged three railroad cars to transport the finished column to straightening presses.

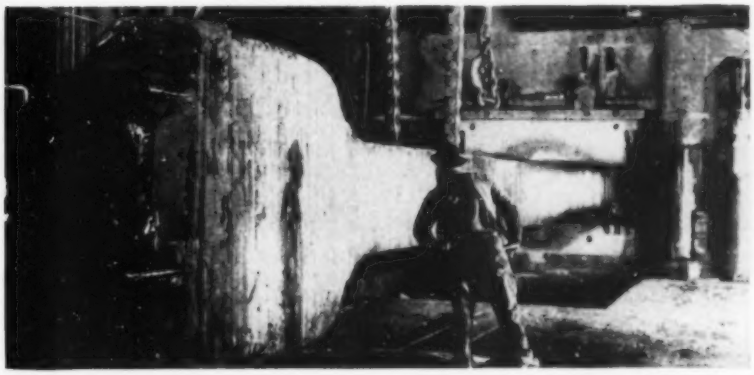
Bigness introduces other problems too. Bethlehem had to build a new furnace 120 ft long, to anneal and relieve stresses set up during the straightening process.

To turn out the flat dumbbell-shaped part, the company uses five heating and forging operations, a one-week heat treating, and a straightening operation. Each heating prior to forging requires seven days to insure an even build-up of temperature. Pictured are four steps in turning out the "world's longest steel forging."

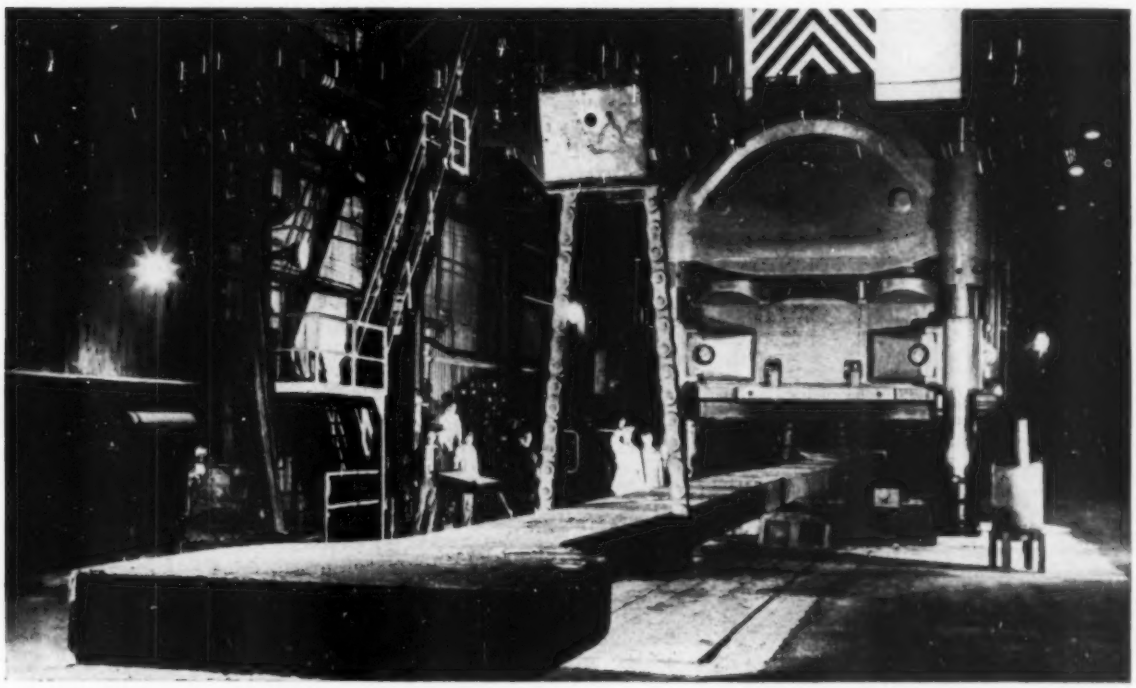
1. RECTANGULAR COLUMN starts as a 275 ton ingot carried to the forge shop in a special railroad car.



2. IN A 7,500 TON PRESS, Bethlehem Steel starts the gradual shaping process. Here is the ingot after the second forging heat, rectangular and stretched.

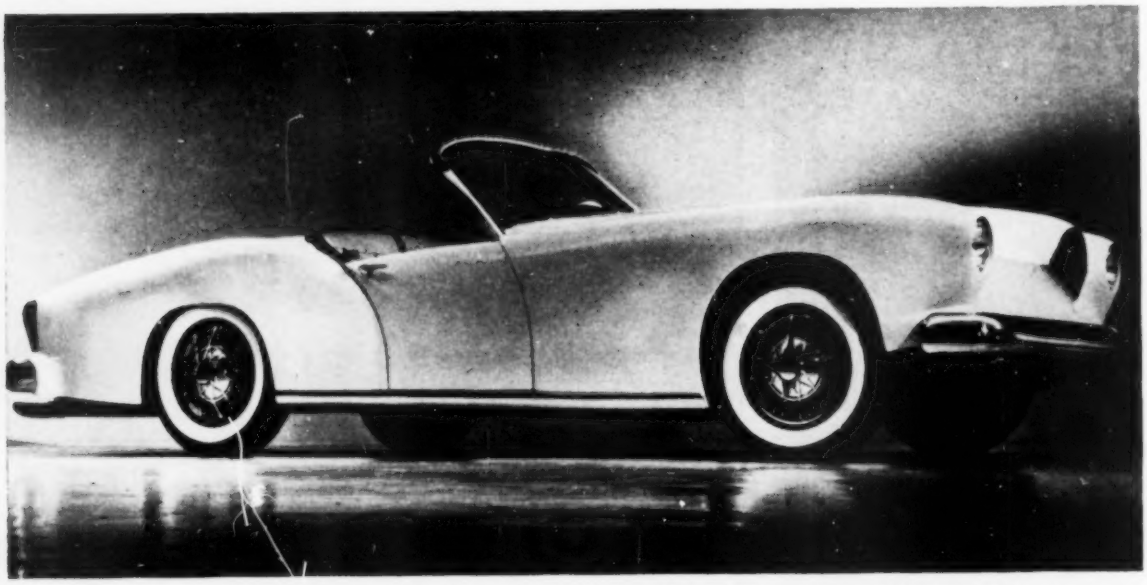


3. AFTER THE FOURTH FORGING heat the column section has increased to 70 ft in length. In this view the press is reducing the main body width to 44 in. Since furnace is only 37 ft long, forging is heated, worked one end at a time.

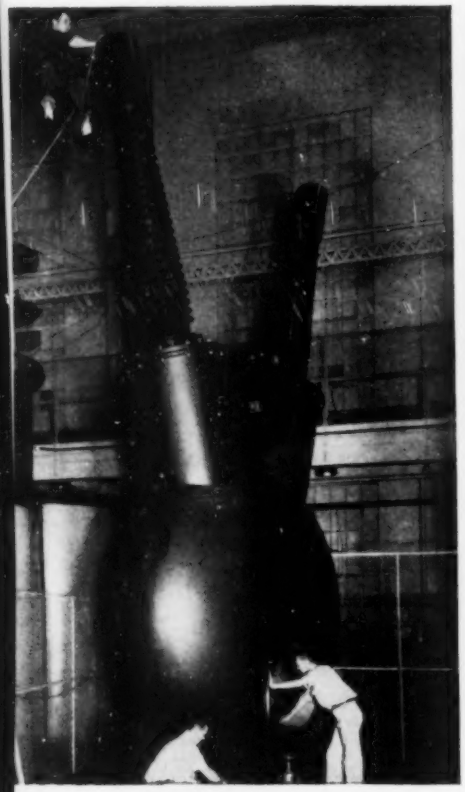


4. COMPLETELY FORGED, the piece is 110 ft long. As a final step it is straightened in a 6,500 ton press. Movement of the final piece is complicated by the fact that the forging bay is only 80 ft wide to handle the 145 ton section.

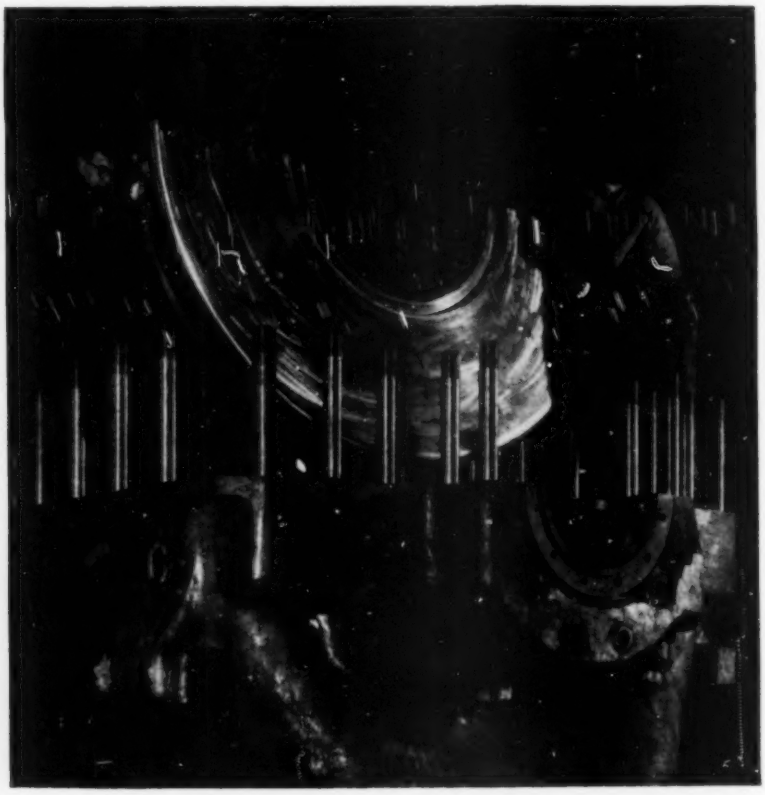
THE NEWS IN PICTURES



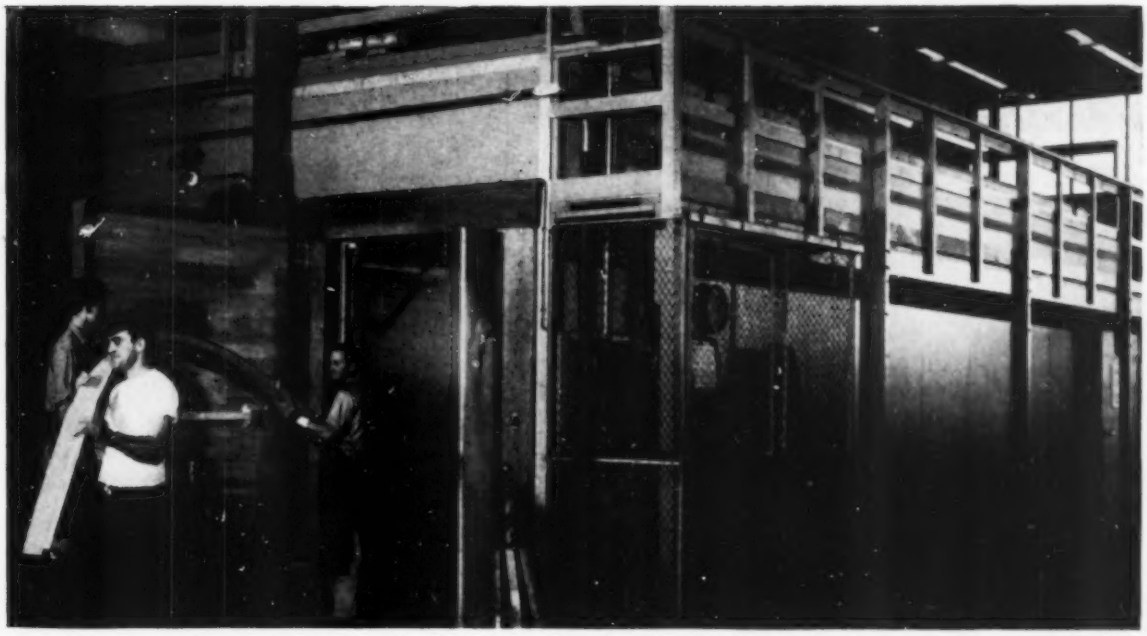
DFK-161, first car to feature a Fiberglass reinforced plastic body, combines European styling with advanced American automotive engineering techniques. To be volume produced by Kaiser-Frazer Corp., automobile will be about 15 ft long, 36 in. high, 69 in. at widest point. Power for 2,000 lb car is developed by 100 hp, 6-cylinder engine with 8:1 compression ratio.



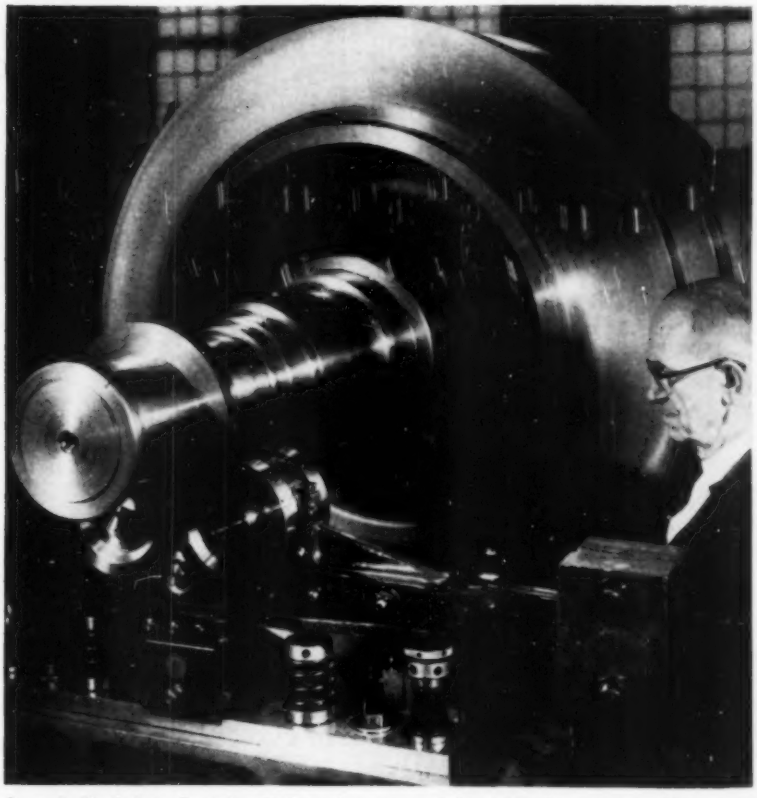
GETTING READY TO TEST a pole unit for GE's huge oil circuit breaker at their Philadelphia Switchgear Dep't. It is rated at 15,000,000 kva.



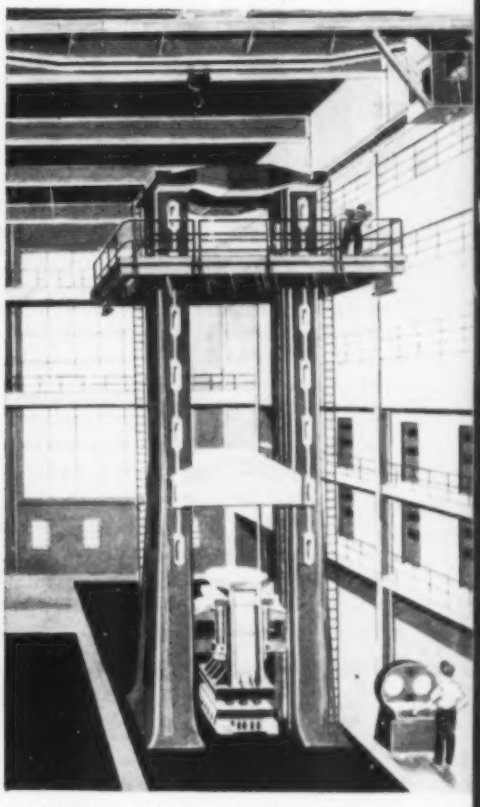
LARGEST FOUR-STAGE CENTRIFUGAL AIR COMPRESSOR ever designed for discharge pressures of 100 psi. One of several under construction at Clark Bros. Co.'s Olean, N. Y., shops, it is rated 100,000 cfm at 3,600 rpm. Pictures show a semi-steel diaphragm being lowered into place between two stages and a 4½ ft rotor being



THREE TIMES AS LARGE AS PREVIOUS TYPES, Lockheed's 5,000 cu ft deep-freeze "preserves" treated airplane parts between manufacturing steps. Measuring 40 by 12 ft and standing 11 ft high, new refrigerator can handle the 32 ft one-piece Constellation wing panels—world's largest integrally stiffened aircraft part. Box is located near big forming machines.

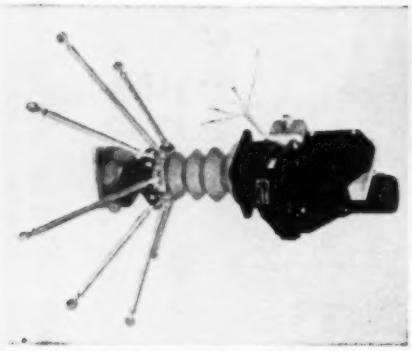


dynamically balanced. The 70 T units, powered by 8,000 hp steam turbines, are slated for use as main air compressors on several big catalytic crackers. Units' size can be gaged by the 3½ in. studs holding the casings together, and the 48 in. dia suction flange, and 30 in. discharge flange.

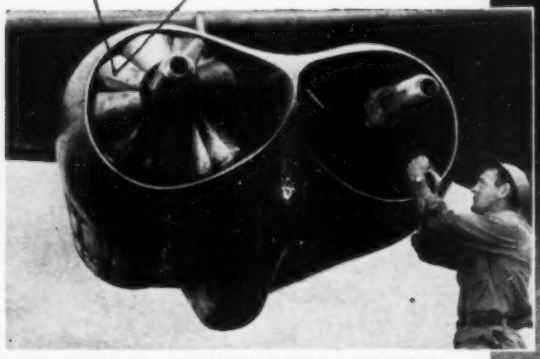


WORLD'S LARGEST vertical universal testing machine to be built at Lehigh University. The 2,500 ton tension-compression unit will be 58 ft. high.

To assure instant operation of jet assist engine air intake doors under icing conditions



COURTESY LEAR INCORPORATED



COURTESY CONSOLIDATED VULTEE AIRCRAFT CORPORATION

SILASTIC*

where other materials fail!

Auxiliary jet engines are fitted with aluminum air intake doors which close to reduce drag when not in use, and open when the engines are summoned for extra bursts of power at take off or in flight.

These doors must always respond to the pilot's instant command on the ground, at sub-zero altitudes or under icing conditions.

This requirement was met by embedding heating elements in a piece of Silastic sandwiched between two sheets of aluminum that are shaped to form the door segments. The Silastic insulates the heating element; withstands surface temperatures up to 450°F, and conducts heat rapidly to the aluminum intake doors.

These doors are opened and closed by means of an actuator and screw jack assembly. To prevent dirt and ice from fouling the screw jack, exposed sections are encased in a heat resistant Silastic bellows that retains its flexibility at temperatures down to −100°F.

In designing this anti-icing assembly, Silastic proved to be the only material that remained resilient and serviceable after continuous vibration and repeated exposure to temperatures ranging from −100°F to +450°F.

Such performance is typical of Silastic, the Dow Corning silicone rubber. When you need a material that will remain rubbery and retain its excellent dielectric properties after long exposure to temperatures from below −70° to above 500°F, or after prolonged weathering or contact with a variety of hot oils and chemicals, ***specify Silastic.***

*T. M. REG. U. S. PAT. OFF.

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Critical Buckling Shear Stresses In Thin Cylinders

J. J. EDEN
Toronto, Canada

AN APPROXIMATE MATHEMATICAL ANALYSIS to determine the critical stress causing elastic instability of thin-wall cylinders subjected to torsion was derived by Donnell (Ref. 1). Modified for closer agreement with measured values, this shear stress can be expressed as:

$$A = 2.8 + \sqrt{2.6 + 1.40\,H^{3/2}} \qquad (1)$$

where

$$A = (1 - \epsilon^2)\,\frac{S}{E}\left(\frac{L}{T}\right)^2$$

$$H = \sqrt{(1 - \epsilon^2)}\;\frac{L^2}{TD}$$

L ..... Length of cylinder
D ..... Diameter of cylinder
T ..... Thickness of cylinder walls
ϵ ..... Poisson's ratio
E ..... Modulus of Elasticity
S ..... Critical buckling shear stress

Eq (1) applies to cylinders with hinged ends, which are defined and illustrated in Fig. 1. Also, it is limited to the following L/D ratios:

$$L/D < 3.3\sqrt[4]{(1 - \epsilon^2)}\;\cdot\sqrt{D/2T} \qquad (2)$$

Substituting for H in Eq (1),

$$S = \frac{E}{1 - \epsilon^2}\left(\frac{T}{L}\right)^2\left[2.8 + \sqrt{2.6 + 1.40H^{3/2}}\right] \qquad (3)$$

Since test data indicate that the actual critical buckling shear stress is about 60 percent of the value obtained from Eq (3), this equation is modified as follows, with ϵ taken as 0.3:

$$S = E\left(\frac{T}{L}\right)^2\left[1.8 + \sqrt{1.2 + 0.57\,\frac{L^3}{(TD)^{3/2}}}\right] \qquad (4)$$

The constants of 1.8 and 1.2 can be neglected if the cylinder dimensions are within these limits:

Thickness	0.04–0.30	in.
Length	10 –120	in.
Dia	2 –25	in.

Eq (4) then reduces to:

$$S = E\,(T/L)^2\sqrt{0.57\,L^3/(TD)^{3/2}} \qquad (5)$$

$$= 0.755E\cdot\frac{T^{5/4}}{L^{1/2}\,D^{3/4}} \qquad (6)$$

For steel, $E = 3 \times 10^7$ and Eq (6) becomes:

$$S = 2.265 \times 10^7\cdot\frac{T^{5/4}}{L^{1/2}\,D^{3/4}}\ \text{psi} \qquad (7)$$

The latter equation was used to develop the nomograph which follows. The error introduced by neglecting the constants 1.8 and 1.2 is negligible for the range of dimensions given. Considering the combination of these dimensions which result in the minimum critical stress, namely, 0.04 in. thickness, 25 in. diameter and 120 in. length, the error determined by comparing Eqs (4) and (5) is 0.18 percent.

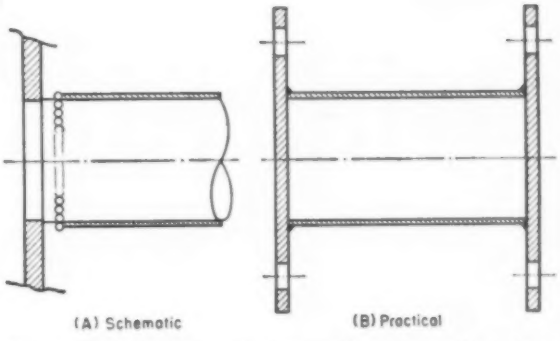

Fig. 1—The equations and nomograph given apply only to cylinders with hinged ends, which are shown ideally in (A). Cylinder end is held by an infinite number of pin points which are held rigidly in a circle. Thus, the end of the cylinder is held circular, but the walls are free to change angle. Practical application which approximates this condition is shown in (B). Cylinder has two relatively thin flanges which are welded to the cylinder on its OD only. Torque is transmitted through bolts which are relatively distant from the cylinder walls, giving the installation the required flexibility.

The maximum error will occur with the combination of dimensions which result in a cylinder with maximum resistance to elastic instability, that is, 0.3 in. thickness, 2 in. diameter, and 10 in. length. The error in this extreme case is five percent, acting in the direction of increased safety. Example:

To determine the criticial buckling shear stress of a cylinder of the following size:

T ..... 0.080 in.
D ..... 6 in.
L ..... 40 in.

(1) Exact solution from Eq (4):
S = 39,910 psi
(2) Critical buckling stress obtained from lines I and II of the nomogram:
S = 39,900 psi

REFERENCES

1. Stability of thin walled tubes under torsion—Donnell—NACA Report No. 479.

2. Aeroplane Structures—Pippard & Pritchard—1935—Chapter XV.

(continued on page 227)

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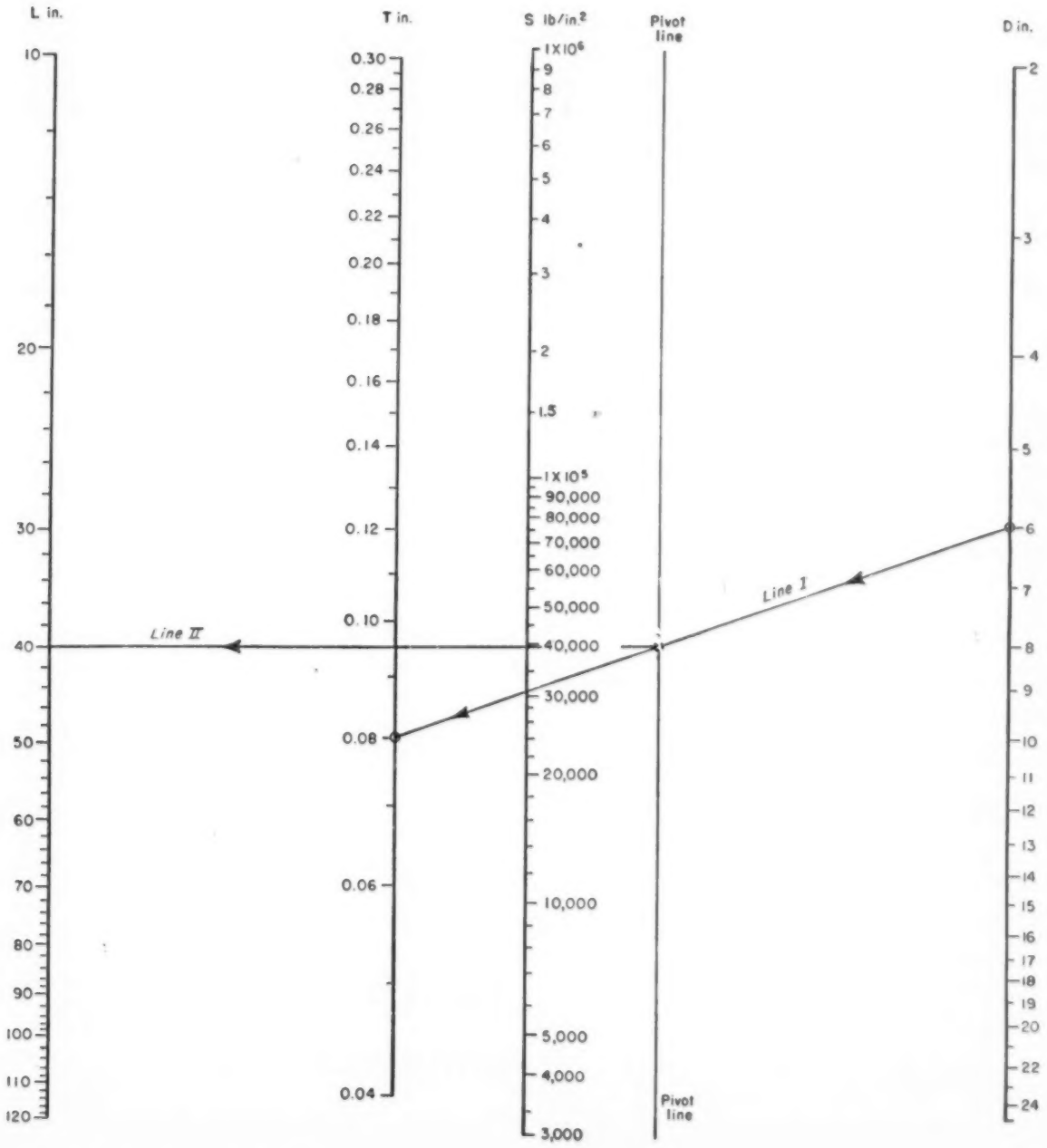
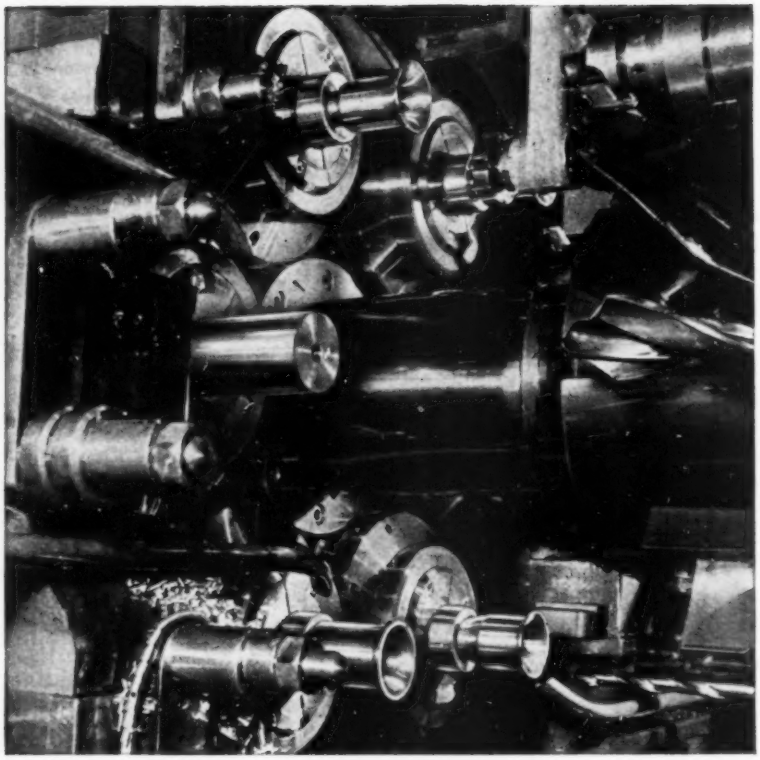
Critical Buckling Shear Stresses in Thin Cylinders (continued)

$$S = 3 \times 10^7 \times 0.755 \frac{T^{5/4}}{L^{1/2} D^{3/4}}$$



Insure Good Machinability

when you select Stainless Bars



Six operations on a Conomatic produce a beverage-filler centering bell of Armco 12 FM, ready for buffing.

It's not enough to specify an analysis of stainless steel bar stock that will meet corrosive conditions and hardness requirements alone. Consider the machining requirements too. If you have a production job you can reduce machining costs by specifying one of the Armco FM (free-machining) stainless steels.

THE FREE-MACHINING TYPES

Armco produces these free-machining types of stainless steel:

Trade Name	Type	Corresponding Basic Type
Armco 18-8 FM Armco 18-8 FM Se	303 303 Se	302
Armco 18-12 Mo FM	316F	316
Armco 18-10 Cb-Ta FM	347F	347
Armco 12 FM Armco 12 FM Se	416 416 Se	410
Armco 13-C-35 FM Armco 13-C-35 FM Se	420F 420F Se	420
Armco 17 FM Armco 17 FM Se	430F 430F Se	430
Armco 17-C-100 FM Armco 17-C-100 FM Se	440F 440F Se	440

(Those grades with Se symbol and Types 316F and 347F have a selenium and phosphorus addition; the others contain added sulfur).

NO CHANGE IN PROPERTIES

The FM grades have essentially the same mechanical properties and corrosion-resistance as their basic companion grades. This means they are generally interchangeable.

BOTH SE AND S

There are two types of free-machining stainless steels, one with a selenium and phosphorus addition, the other with a sulfur addition. Although each alloy has its particular advantages, the sulfur type costs less and is available. The selenium type is under Government allocation and its use is restricted.

For more information on the Armco FM stainless steels, get in touch with our nearest sales office, or write us at the address below.

ARMCO STEEL CORPORATION

2453 Curtis St., Middletown, O. Export: The Armco International Corporation

Recommended Welding Processes

JOHN J. CHYLE
Director of Welding Research, A. O. Smith Corporation
Milwaukee, Wis.

R = recommended S = satisfactory NR = not recommended NA = not applicable.
Light Section: 0.005 to 0.125 in. Heavy Section: ⅛ in. and over

	Shielded Metal-Arc (Coated Electrode)	Submerged-Arc	Atomic Hydrogen	Inert Gas Tungsten-Arc	Inert Gas Metal-Arc	Flash Welding	Spot Welding	Seam Welding	Gas Welding (Oxyacetylene)	Brazing—furnace	Brazing—torch	Thermit
BASED ON WELDED MATERIALS												
Low carbon mild steel types SAE 1010 SAE 1020	R	R	S	S	S	R	R	R	R	R	S	S
Medium carbon steel types SAE 1030 SAE 1050	R	R	S	S	S	R	R	S	R	R	S	S
Wrought alloy engineering steels SAE 4130 SAE 4340	R	R	S	S	S	R	R	NR	S	S	NR	S
High alloy stainless steels, austenitic types AISI 301-309-316	R	R	R	R	R	R	R	R	S	S	S	NR
Stainless steels, ferritic and martensitic types AISI 405-430	R	S	S	S	S	S	S	S	S	S	S	NR
High temperature alloys 19-9DL 16-25-6	R	S	S	S	S	S	S	R	S	NR	NR	NR
Cast iron, Gray iron	S	NR	NR	S	NR	NR	NA	NA	R	NR	R	S
Aluminum and aluminum alloys	S	NR	S	R	R	S	R	S	S	R	R	NA
Nickel and nickel alloys	R	S	S	R	R	S	R	S	S	S	R	NR
Copper and copper alloys	NR	NR	NR	R	R	S	S	NR	S	S	R	NR
Magnesium and magnesium alloys	NA	NA	NR	R	S	NR	S	NR	NR	NR	NR	NA
Silver	NR	NR	R	R	S	S	NR	NR	R	S	R	NR
Gold, Platinum, Iridium	NR	NR	R	R	S	S	S	NR	R	S	R	NR
Titanium and titanium alloys	NA	NA	NA	R	NR	S	S	NR	NA	NR	S	NA
Uranium, Molybdenum, Vanadium, Zirconium, Tungsten	NA	NA	NR	R	NR	S	S	S	NR	NR	NR	NR
BASED ON JOINT DESIGN												
Butt Joint — Light section	S	S	R	R	NR	NR	NA	NA	R	NR	S	NA
Butt Joint — Heavy section	R	R	S	S	R	R	NA	NA	S	NR	S	R
Lap Joint — Light section	R	S	S	R	NR	NA	R	R	R	R	R	NA
Lap Joint — Heavy section	R	R	S	S	R	NA	R	R	S	R	R	NA
Fillet Joint — Light section	R	S	S	R	NR	NA	NA	NA	R	R	R	NA
Fillet Joint — Heavy section	R	R	R	S	R	NR	NA	NA	S	R	R	NA
Edge Joint — Light section	NR	NR	R	R	NR	NA	NA	R	R	NA	S	NA
Edge Joint — Heavy section	R	S	S	S	S	NA	NA	R	S	NA	S	NA
Overlay Welding	R	R	R	R	R	NA	NA	NA	R	NR	S	NR

(Based on E.A.E. paper)

Balanced Vane Type Hydraulic Motors

Having variable horsepower (constant torque) characteristics, a new line of oil hydraulic balanced vane type motors can be used for continuous, intermittent or continuously reversing service, and can be stalled under load without damage.

Fig. 1 shows how both axial and radial wear are automatically compensated for at all times. A shuttle valve introduces fluid pressure from whichever port is the inlet to the space behind the pressure plate to maintain optimum axial running clearances throughout the complete pressure range. If radial wear occurs, the vanes revolve in a slightly larger orbit.

All vanes are always in contact with the cam ring, regardless of motor speed or if the motor is stopped. As shown in Fig. 1, each pair of vanes at 90 deg. to each other (a_1 and a_2, b_1 and b_2, etc.) is actuated by a rocking beam (one on each side of the rotor) that is pivoted to the rotor by a roller. As one vane is being pushed in by the cam contour of the ring, its complimentary vane (at 90 deg.) is being pushed outward by the rocking beams.

The rocking beams are pre-loaded so that there is always an outward force on the vanes tending to extend them. These rocking beams are not flexed in service as springs would be, and are therefore, not subject to such fatigue.

The shuttle valve introduces oil under pressure (regardless of which port is the inlet) to the area underneath the vanes. This also acts to keep the vanes in contact with the cam ring.

With the two inlet and outlet ports opposite each other, bearing loads resulting from pressure are eliminated. Freedom from trapping of oil also minimizes bearing loads and gives quiet operation. In addition, a lubricating oil film on both rotor faces and vanes is automatically maintained. Maximum recommended pressure for continuous duty is 800 psi, with the horsepower being approximately directly proportional to the speed and operating pressures.

The head port can be placed in any one of four positions relative to the body port by unbolting and rotating the head. Motors are available with: flange or foot mounting; drives directly coupled; or through belt or chain gear.

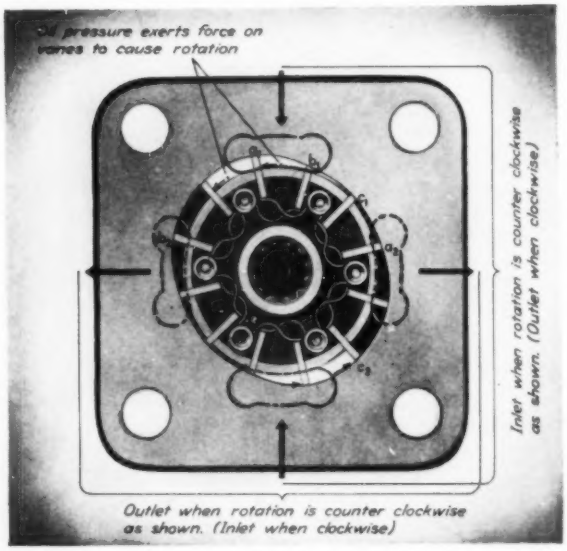

Oil pressure exerts force on vanes to cause rotation
Inlet when rotation is counter clockwise as shown. (Outlet when clockwise)
Outlet when rotation is counter clockwise as shown. (Inlet when clockwise)

FIG. 1 Using a "rocking beam" construction, the vanes are kept in contact with the cam ring. A combination of the low inertia of the moving parts and the automatic wear compensation for both radial and axial clearances increases efficiency.

Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.

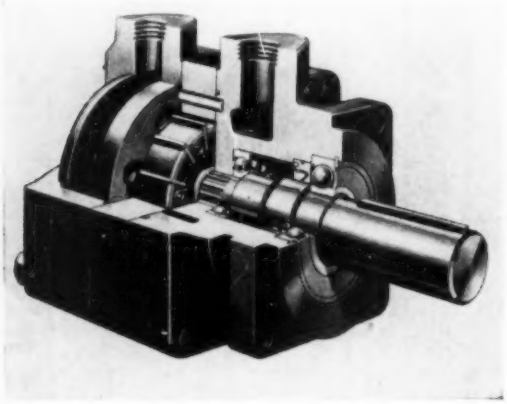


FIG. 2 Shown in the cutaway view of one of the balanced vane type hydraulic motors are the two heavy duty ball bearings widely spaced on the shaft. The shaft, rotor and vanes are of heat-treated alloy steel.

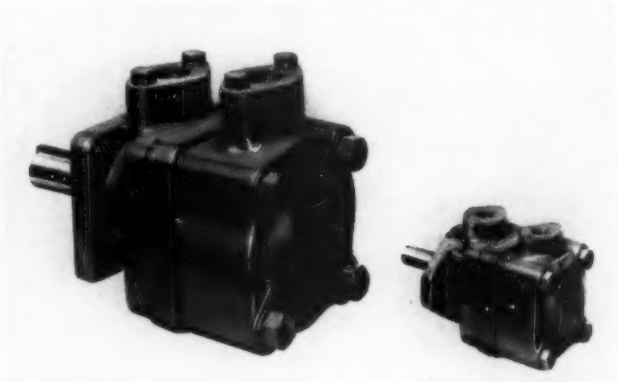


FIG. 3 The Series M-500 at left and the M-200 at right for 5.0, 6.5, and 26 hp. output are the two models available. There is also a choice of four combinations of inlet and outlet port positions, and flange or foot mounting. Running clearances are automatically maintained.

Camera Records Position Vs. Time Relationship

Based on the action of a mirror which rotates at a speed of 50,000 rpm and wipes an image onto a film at a sweep rate of 5.466 mm. per micro sec., a new research camera has been designed for the study of self-luminous transient events such as explosive, flash tube, and spark-discharge phenomena.

In Fig. 1, the operator is shown adjusting the film on the camera. The high speed rotating mirror is located inside the upper right section of the housing below the vertically-projecting knob. The knob holds a vacuum-tight round access panel through which the mirror is rotated before a photographic run.

A mechanical schematic view of the camera housing is shown in Fig. 2. The self-luminous image of the test object is projected through the slit by an external condenser lens which is not part of the instrument. The internal lens forms an inverted non-magnified image of the slit in the film plane after reflection from the mirror surface whose rotation sweeps the image across the film surface at a selected sweep rate in the direction shown. Any sweep rate may be chosen between 0.327 and 5.466 mm. per microsecond. Therefore, the sequence of events at the test object which takes place in the vertical area imaged in the slit is separated in time as it is spread across the film.

Normal photographs of the test object can be taken in such a way that an image of the slit is superimposed as a reference to show the section of the object which will be photographed during the test. Due to the high speed of operation, the mirror must be rotated in a vacuum. The camera housing is designed for this purpose and is equipped with a mechanical vacuum pump located in the lower portion of the stand.

Synchronizing of the exposure with actuation of the test object is accomplished through the pip-generating commutator seen on top of the mirror in Fig. 2. Each turn of the mirror produces a 15-volt minimum pulse which is used to trigger and synchronize the test object so that the image will be positioned on the film.

The slit plate is formed by a piece of flat glass having an opaque coating on one side through which the slit line has been ruled. This plate is movable for the taking of conventional photographs. The slit width is 0.010 in.

The shutter is a high-speed guillotine type designed to prevent multiple exposure when phenomena of long duration are being observed. Operated by external electrical impulse, the shutter can also be used to actuate related equipment. Exposure time is 1/200 sec.

Lenses are color corrected for the 4500 A region, coated, and have resolving power of 30 lines per millimeter.

The stainless steel mirror has a working surface optically flat to one circular fringe and may be rotated at continuously-adjustable speeds ranging from 3000 to 50,000 rpm. Reflecting surface is 3¾ by 4 inches.

Beckman & Whitley, Inc., 985 San Carlos Ave., San Carlos, Calif.

FIG. 1 The event to be studied is oriented before the vertical slit shown at the upper left, and the photographic record is obtained on a 4 by 5 in. film located in the film holder.

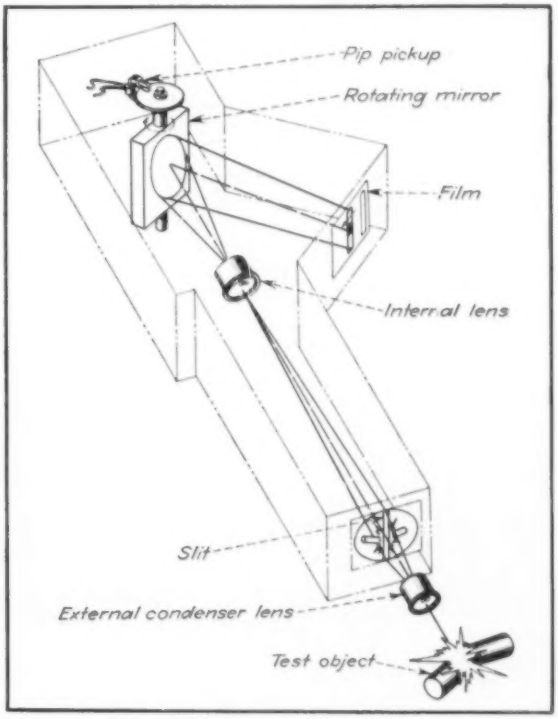
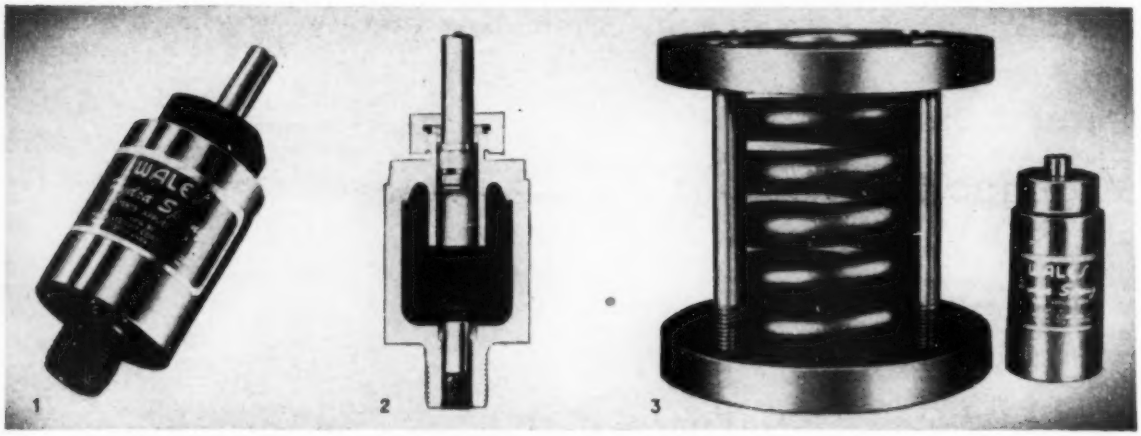


FIG. 2 In the mechanical schematic view of the camera, the self-luminous image of the test object is projected through the slit by an external condenser lens not part of the instrument.

CONTINUED ON PAGE 232

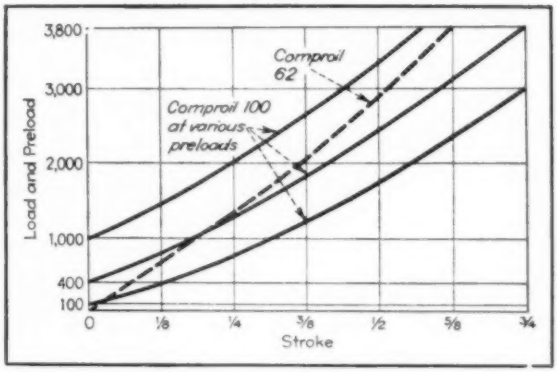


Hydraulic Unit Gives High Stripping Pressures

Using the compressibility of special fluids, the new Hydra-Spring is said to eliminate many stripping problems by giving up to 600 percent greater stripping pressure than ordinary coil springs of similar size. The special fluid used in this device is called Comproil. Stripping pressures may be adjusted by adding or reducing the volume of this fluid, which also provides a resilient action produced by conventional springs. In addition to simplifying die design and die making, the manufacturers claim that it is possible to make die operations that were previously impossible.

Shown in the illustrations from left to right are: (1) the exterior of the unit; (2) a cross-section view showing internal construction; (3) and the comparison of Hydra-Spring that will deliver as much spring pressure as a railroad car coil spring.

A graph showing characteristics with various comproils, strokes, loads, and pre-loads is shown at right.



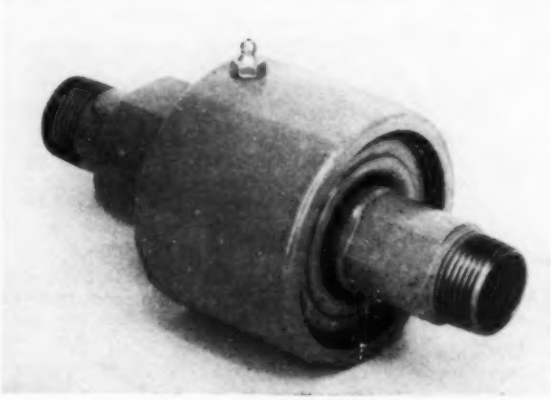
Wales-Strippit Corp., 345 Payne Ave., North Tonawanda, N. Y.

High Pressure Rotary Steam Joint

Long life and maximum performance, with minimum servicing requirements, are the features of a new rotary pressure joint consisting of only 14 parts, including all washers, and oil rings.

The rotary joint will convey steam under pressures up to 350 psi and liquids under pressures up to 3500 psi, while rotating at high speeds. Equipped with a self-adjusting wear take-up, the units have single or double race ball bearings. Efficiency of the sealing members cannot be affected by any misalignment or eccentricity up to 10 degrees. An auxiliary seal prevents any loss of grease or condensate past the bearing. The joint will operate at temperatures from —100 to 600 F.

The joint is self-supporting and can be used with or without a syphon. Available in pipe sizes from ¾ in. up to 5 inches.



Anco, Inc., 1 Baker St., Providence, R. I.

CONTINUED ON PAGE 234

IRVINGTON
INSULATING VARNISH DIGEST

Air Drying Varnishes Increase Protection, Improve Appearance

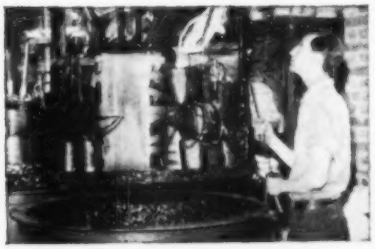
Air drying varnishes produced by Irvington Varnish & Insulator Company find one of their major fields of utility in increasing the degree of electrical protection given to windings by impregnation with either internal curing or conventional baking varnishes.

These air drying varnishes also improve the finished appearance of the insulated winding.

In cases where baking facilities are not available, these varnishes can be used for quick repair and maintenance jobs. Some types have sufficient heat endurance to permit their use as quick baking varnishes for maintenance work. Others have excellent metal adhesion and can be used as coatings for conduit, switch and signal boxes.

A list of air drying varnishes is available on request.

Internal Curing Varnish Bonds Windings Rigidly



Coils are rigidly bonded into a compact mass free from soft, sticky interiors when polymerizing, though curing varnishes are used. This has been the experience of numerous companies who have used Irvington internal curing varnishes for many years.

Manufacturers have also found that the internal curing method permits the use of fast baking schedules. Baking times have been cut up to 50%, thus speeding up output and reducing production costs.

Information on internal curing varnishes is available on request from Irvington.

Dipping Gives Good Winding Penetration With Simple, Moderate-Cost Equipment

Method is Extensively Used for the Application of Insulating Varnish to Electrical Equipment

The dipping procedure offers an excellent method of impregnating electrical windings with insulating varnish, provided the windings are not constructed in a manner necessitating the more thorough impregnation made possible by the use of vacuum or pressure types of application.

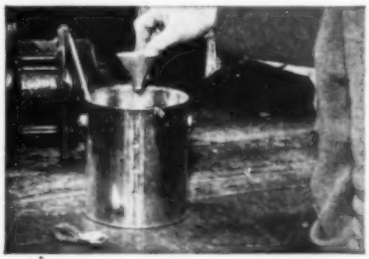
Dipping provides an economical means of applying insulating varnish to many types of electrical windings.

Outstanding advantage of the dipping method is the relative simplicity of the equipment involved, as well as of the production procedures. The dipping tanks are usually made of steel, although heavy galvanized iron is also used successfully. Tanks should be equipped with closely fitted counterbalanced covers, and provided with outlets for draining off the varnish to permit cleaning. They must also be of sufficient size to allow complete immersion of the pieces to be treated without causing any large change in varnish temperature.

Varnish Consistency Should be Checked Before Application

Insulating varnishes are usually supplied at a somewhat heavier consistency than is required for application, and should be thinned with suitable solvents.

Once the proper consistency to give the desired film thickness has been determined by experiment, a viscosity reading should be taken. The varnish should be maintained at this viscosity to insure uniform results. Many viscosity measuring devices are available, most of which are easy to use.



Viscosity should be checked daily and adjusted to the proper viscosity with the solvent recommended for the particular varnish. Since viscosity varies with temperature, it is important that the varnish temperature be the same each time a check is made.

Preparation of Units

Units should be cleaned, dried and preheated before immersion in the varnish. They should remain in the varnish until all air bubbles cease rising to the surface. Longer immersion will assure more thorough impregnation. Units should be withdrawn slowly and allowed to drain until dripping ceases.

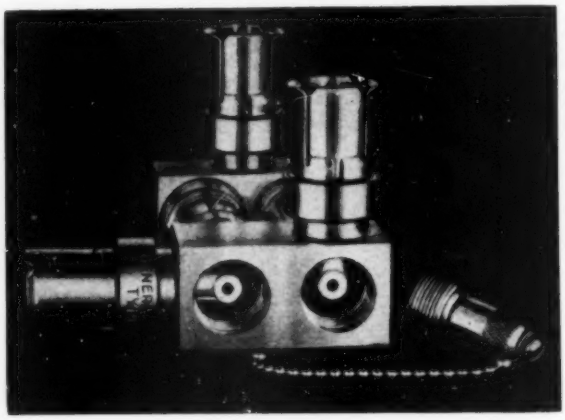
Types of Varnish

Both the conventional baking and the internal curing types of varnish manufactured by Irvington may be applied by the dipping method. It should be noted, however, that the internal drying types, which cure throughout by polymerization, are particularly adapted to the impregnation of deep windings. To assure the deep penetration for which these varnishes are designed, it is advisable to consider the use of vacuum or pressure equipment when unit construction hinders varnish passage.

Irvington's Research Department is prepared to assist varnish users in selecting types of electrical insulating varnishes for specific applications, and to advise on methods of application and baking schedules.

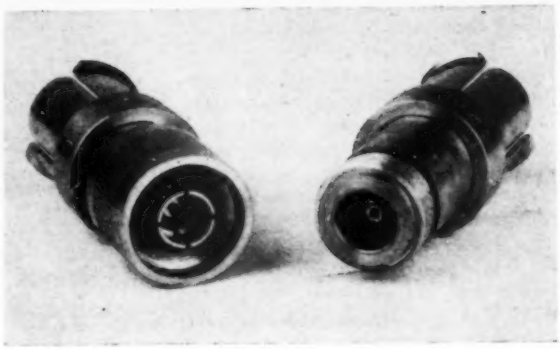
(For further information, write the Sales Manager, Varnish Dept., Irvington Varnish & Insulator Co., 10 Argyle Terrace, Irvington, N. J.)

Coaxial Adapters And Accessories



A line of coaxial connectors having good electrical characteristics may not only be used when measurements are made on equipment fitted with military type connectors, but also may be used to interconnect systems using any of the various connectors. The type 874 connector has been established as standard, with most of the equipment designed around this part. This includes: (1) a line of adaptors which will permit interconnection of type 874 equipment with other commonly used coaxial systems; (2) a constant impedance line stretcher, adjustable from 58 to 80 cm; (3) a component mount to simplify the measurement of resistors, capacitors, inductors, and other circuit elements; (4) a Balun for converting balanced to unbalanced impedances, (5) short, and open circuit terminations to aid in setting up measuring equipment; (6) and an insertion unit for mounting arbitrary coaxial networks.

Shown at right, below, are type 874 Adapters, designed to connect measuring equipment using type 874 coaxial connectors to other pieces using any of the common high-frequency coaxial connectors: type N, type C, type BNC, and type UHF.



Shown at right, above, is the 874-UB Balun, used for the measurement of balanced impedances. It has been designed to use an artificial half-wave line, which, when tuned to the operating frequency, makes the conversion without appreciable loss in the Balun itself. It can be used over a frequency range from 50 to 1000 megacycles, and has been made tunable so that the best possible accuracy can be obtained at any frequency within its range.

General Radio Co., 275 Massachusetts Ave., Cambridge 39, Mass.

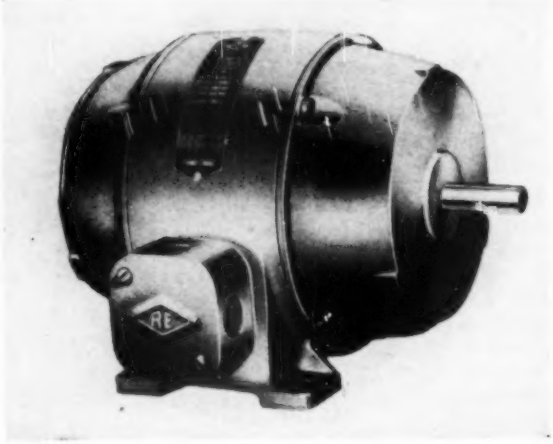
Multi-Speed Motors For Special Jobs

Multi-speed motors are now available in 2, 3, or 4 speeds in either: constant torque; variable torque; or constant horsepower types. Two speed motors are supplied with either 1 or 2 windings, and 3 and 4-speed motors with 2 windings only. Motor sizes range from ½ to 150 hp.

In the constant torque types, uses are found on equipment where the loads require an almost constant turning effort, regardless of the motor's speed. With this motor the hp output varies directly with the rpm. Used with: printing presses; conveyors; and air compressors.

The variable torque motor is suited to powering loads that develop and maintain their momentum. With such loads a reduction in the operating speed is accompanied by a greater reduction in required operating horsepower. The horsepower-to-speed reduction ratio of a variable torque motor rated at 20 hp., 1800 rpm is 5 hp. at 900 rpm. Applications are: fans, blowers, and centrifugal pumps.

The constant horsepower motor is used on equipment where the horsepower required is constant regardless of the operating speed. It is suited for jobs that require a constant amount of power, such as encountered with a lathe where various speed and cutting characteristics are required for different diameters of work. Typical applications are: drill presses, shapers, grinders, metal and woodworking lathes, boring machines and others.



The multi-speed motors can be furnished in either standard, totally enclosed, splash-proof or explosion-proof designs. They are also available as Motoreducers and with magnetic brakes.

Reuland Electric Co., Alhambra, Calif.

CONTINUED ON PAGE 236

Where

are Adlake Mercury Relays particularly fitted to function?

In any installation that requires both sensitivity and lasting dependability . . . from traffic control systems to long range navigation equipment . . . ADLAKE Mercury Relays will give superior service!

Here are just a few of ADLAKE'S many applications:

- Radio transmission
- Standard telephone circuits
- Precision control instruments
- X-ray control
- Air-conditioning and refrigeration controls
- Voltage regulators
- Incubators
- Production time controls
- Animated displays
- Duplicator controls
- Communication equipment
- Remote controls
- Alarms

The same engineering skill . . . the same high quality control standards . . . that have insured dependability in these installations are available for your relay problems. If you don't find the relay you need in the ADLAKE catalog, it will be custom-built for you. Write for full information today—The Adams & Westlake Company, 1169 N. Michigan, Elkhart, Indiana. In Canada write: Powerlite Devices, Limited, of Toronto.

EVERY ADLAKE RELAY GIVES YOU THESE PLUS FEATURES:

HERMETICALLY SEALED—dust, dirt, moisture, oxidation and temperature changes can't interfere with operation.

SILENT AND CHATTERLESS • REQUIRES NO MAINTENANCE.

ABSOLUTELY SAFE • MERCURY-TO-MERCURY CONTACT—prevents burning, pitting and sticking.

—And every ADLAKE is tested—and guaranteed—to meet specifications!

Adlake 96th year of serving the transportation and building industries

THE Adams & Westlake COMPANY

Established 1857 • ELKHART, INDIANA • New York • Chicago

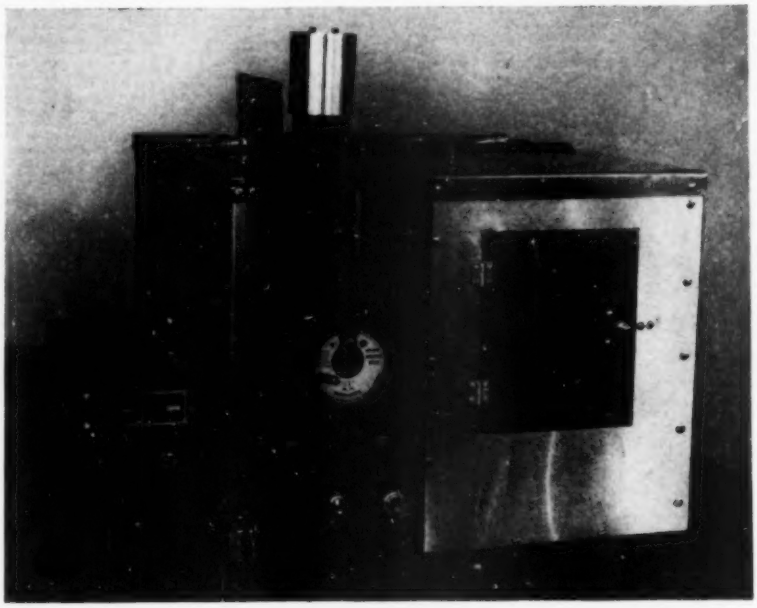
Manufacturers of ADLAKE Hermetically Sealed Mercury Relays

Device Weighs, Sorts, And Classifies Pieces

To a line of precision weighing instruments have been added models which automatically sorts pieces, and packages and classifies them by weight. Such units have been used to check-weigh and reject off-standard pieces of die castings.

These models feature a "pick-up and take-away" mechanism which duplicates the hand method of placing pieces and packages on the scale, and which cycling may be synchronized with standard conveyors having relatively high speeds. The equipment is adaptable for placing in conveyor lines for check-weighing cans, bottles, or packages which have been filled by automatic filling machines, and where uniform volume is required.

Weight sensing is accomplished by electronic means. It rejects pieces or packages on over and under weights based on tolerance ranges which are adjustable, and which may be kept to close limits of standard. Standards may vary from milligrams to pounds, and of almost unlimited physical size.



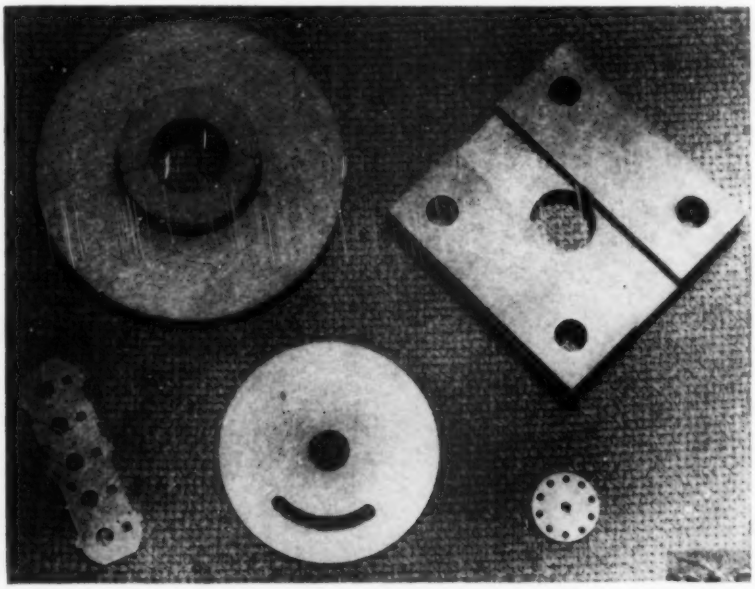
H. A. Hadley Associates, Inc., 41 Barlow St., Winooski, Vt.

New Laminate For Power And Lighting Applications

Combining high fire and arc resistance with good mechanical and chemical properties, a new laminate called G-8 is available in standard 36 x 36 in. sheet sizes, and ranges in thickness from $\frac{1}{16}$ in. on up. The new material uses a glass fibre mat impregnated with melamine resins, and is said to offer a saving under the cost of the continuous filament glass-base material (NEMA grade G-5) whose electrical properties it matches.

Flexural strength, flat-wise, $\frac{1}{2}$ in. thick sample: lengthwise direction 24,000 psi, crosswise direction 20,000 psi; Impact strength, edgewise, $\frac{1}{2}$ in. thick sample: lengthwise direction 6.0 ft.-lb., crosswise direction 6.0 in. notch; water absorption, 24 hours: $\frac{1}{16}$ in. thickness 2.7 percent, $\frac{1}{8}$ in. thickness 2.0 percent, $\frac{1}{2}$ in. thickness 1.50 percent; Dielectric breakdown $\frac{1}{8}$ in. thick sample: parallel to laminations 65 KV, perpendicular to laminations 200 V per mil; Bond Strength, 1200 lb; Arc Resistance, 185 sec.; Dissipation Factor at one megacycle $\frac{1}{8}$ in. thick D24/25, 0.07.

In addition to the electrical applications, the new laminate is said to have applications where chemical resistance is required, such as in plating and photographic industries.



The new laminate also has good machining qualities.

Synthane Corp., 24 River Road, Oaks, Pa.

CONTINUED ON PAGE 238

CONTINENTAL'S PROOF BOOK

R. E. Brumbaugh

Secretary and Purchasing Agent of the Auer Register Company, Cleveland, Ohio. Mr. Brumbaugh supervises all of the buying for this concern, which is one of the leading manufacturers of registers and grills in the country.

THE Auer REGISTER COMPANY
6600 CLEMENT AVENUE, CLEVELAND 5, OHIO

March 13, 1953

Continental Screw Company
New Bedford, Massachusetts

Gentlemen:

This is to inform you of the very gratifying results which we have experienced since using your Holtite taped screws in our operation.

It is necessary to supply two installation screws with each of our units, and we had for many years been packaging them in small cloth bags secured with a tie-string. A considerable saving was experienced when we substituted a kraft envelope for the cloth bag. The advantages realized by subsequent conversion to Holtite taped screws are obvious when you examine the following table of costs:

Packaging Unit		Packaging Labor	Total
Bag	$3.75M	$2.40M	$11.15M
Envelope	1.90M	2.05M	3.95M
Taping	.90M	-0-	.90M

This table tells a story, and it is indeed a good one. However, it does not point out the many errors of mixing and improper selection which taped screws have eliminated in our own handling.

We sincerely appreciate the personal touch and follow-up which are characteristic of Continental in supplying us with a product unsurpassed in quality.

Yours very truly,

THE AUER REGISTER COMPANY

R. E. Brumbaugh

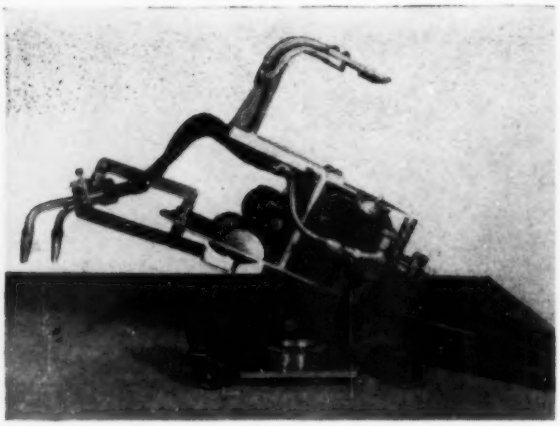
Secretary

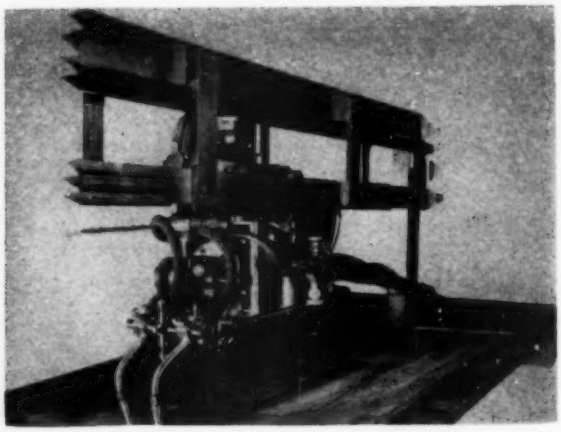
You too can count on Continental.©

CONTINENTAL SCREW COMPANY INC. 1904

Manufacturers of HOLTITE Fastenings For Every Purpose

CONTINENTAL SCREW COMPANY, NEW BEDFORD, MASS., U.S.A.





Machine Bonding of Lead to Steel or Copper

Producing a good chemical bond between lead and steel, a new automatic machine is claimed by its manufacturers to be able to clad a steel surface in one day that would ordinarily require 8 to 10 man-days by hand methods.

With this method the steel is first prepared through leadizing, then lead of any thickness can be applied. The lead will not separate from the steel in service unless it is melted off at temperatures close to 621 F., the melting temperature of lead.

Such machines will chemically bond a strip of lead up to 12 in. wide by ¼ in. thick to prepare steel. The operator can control the width and thickness of the lead cladding by regulating the speed of the machine and by spreading or narrowing the two cladding heads on it.

The machine does not have to carry its own lead supply. A strip of lead is laid down under the machine, and the cladding heads melt this lead and chemically bond it to the steel as the machine automatically moves across the plate. The machine may also carry its own lead supply in tubular feeds at the front of the unit. While the machine may run free, directly on the steel, it will also operate on a track. By taking off the bottom carriage, reversing it, and mounting it on the top of the machine, the unit will run on a light-weight aluminum or magnesium beam so that it may be operated in a tank shell.

Weighing less than 15 lb., the whole carriage may be turned to clad lead on either the right or the left side. The machine does not become warm during operation.

A hand operated model is also available. The hand tool may be used to burn lead as in welding sheet lead and pipe. The hand unit, weighing less than 10 lb., operates without a carriage on a single wheel or tripod arrangement with a grip for the operator.

The view at the left shows the machine with the tripod swivel base. At right is the unit suspended from a rail, along which it is moved by its own power.

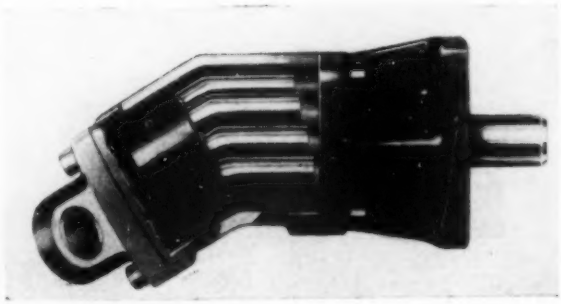
Knapp Mills, Inc., 23-17 *Borden Ave., Long Island City* 1, *N. Y.*

New Pump Uses Telescoping Sleeves

With positive displacement for pressures to 500 psi, the new V-9 pump, model 100 delivers from 2.4 gpm to 7.2 gpm at pressures from 9 psi (20 head ft.) to 433 psi (1000 head ft.), depending upon the speed at which it is operated and the power applied. Total length of the unit shown is 7¼ inches long.

The pump operates on a new principle, the telescoping sleeve, shown in the illustration. There are 9 sleeves which extend into each of the 2 cylinder blocks whose angular relation to each other cause the telescoping cylinder effect when the cylinder blocks are rotated. No connecting rods, gears, springs, or cams are required. The total pump assembly uses only 15 parts. All components are balanced to reduce vibration, and no lubrication is ever required.

The pump is supplied with either a bronze or aluminum case, with the component parts made from materials to give long life and reduce the contamination by the fluids being pumped. A special shaft seal will withstand high speed rotation and inlet pressures up to 200 psi. Operating temperatures are from —60 to 165 F, with fresh water, salt water, oil, gasoline, and chemicals being handled.



Eastman Pacific Co., 2320 *E. 8th St., Los Angeles* 21, *Calif.*

CONTINUED ON PAGE 241

...craft
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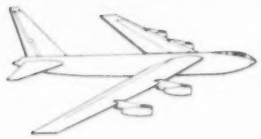
...ting Requirements.

Since World War I, welding has been our business and today every U. S. jet engine manufacturer is a user of "American Welding" component parts. If your requirements involve either fusion or resistance welding of ferrous or non-ferrous metals, drop a line to our Product Development Division. We can provide complete designing, engineering, metallurgical and machining facilities and will be glad to put our 34 years of welding experience to work on your problem.

THE AMERICAN WELDING & MANUFACTURING COMPANY
WARREN, OHIO • 140 DIETZ ROAD

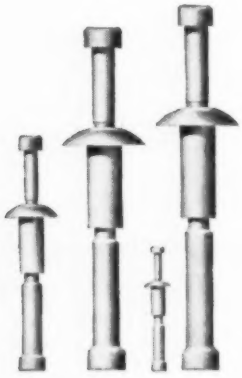


"A plane is a collection of aluminum holes held together by rivets," an aircraft designer once said jokingly in emphasizing the importance of rivets to aircraft construction. The majority are solid rivets which are driven and bucked by conventional methods. But a vital minority are actually precision parts, such as Cherry Blind Rivets, of which as many as 250,000 are used in one super-bomber—60,000 in a smaller fighter or transport.

These ingenious fasteners are set quickly and easily by one man from one side of the work with a special tool that pulls the rivet tightly into place without bucking, hammering or exploding. Blind rivets are virtually indispensable to modern plane construction as their use makes possible riveting in difficult-to-reach places, thus permitting freedom of design not possible with other types of fasteners. This feature also enables manufacturers to cut unit costs and speed production.

Townsend's Cherry Rivet Division at Santa Ana, California, is dedicated to the production and perfection of this single product. Here, highly trained personnel using Townsend designed and built equipment devote their entire attention to the manufacture of these precision rivets which are matched and tested against an elaborate set of specifications in order to give the excellent performance required. The greatest portion of Cherry Rivet production goes into military aircraft and will continue to do so as long as the nation's aircraft needs remain critical.

Cherry Blind Rivets are only one of some 10,000 different types, sizes and kinds of Townsend fastening devices produced at its several plants. With all these items at their command, Townsend engineers are able to give you unbiased advice—help select or design the fastener best suited for your product or assembly methods. A folder describing Townsend fasteners which are used to increase efficiency and improve products is yours for the asking.



Townsend

COMPANY • ESTABLISHED 1816

NEW BRIGHTON, PENNSYLVANIA

Sales Offices in Principal Cities

Cherry Rivet Division • Santa Ana, California

THE FASTENING AUTHORITY—Experience: *over 137 years*—**Capacity:** *sixty-million parts daily*—**Products:** *over ten-thousand types of solid rivets—cold-headed parts—Cherry Blind Rivets—Twinfast Screws—self-tapping screws—tubular rivets—locknuts—special nails—formed wire parts.* **Plants:** *New Brighton, Pennsylvania—Chicago, Illinois—Plymouth, Michigan—Santa Ana, California.*

Self-Generating Miniature Velocity Pickup

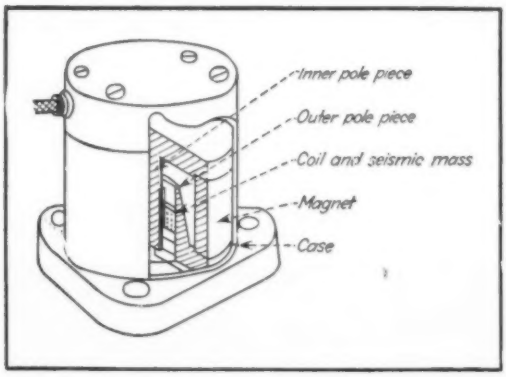
Designed for operation at the elevated temperatures found in the testing of aircraft turbines, reaction motors and superchargers, a vibration measuring instrument 1 x 1 in. and weighing only 1.3 oz. can operate continuously at 300 F or as high as 500 F for intermittent periods of up to 100 hours. A self-generating velocity pickup, the model 4-118 is a dual-purpose instrument that can be used either with visual meters for vibration monitoring or with multi-channel recording oscillographs where a permanent record is necessary.

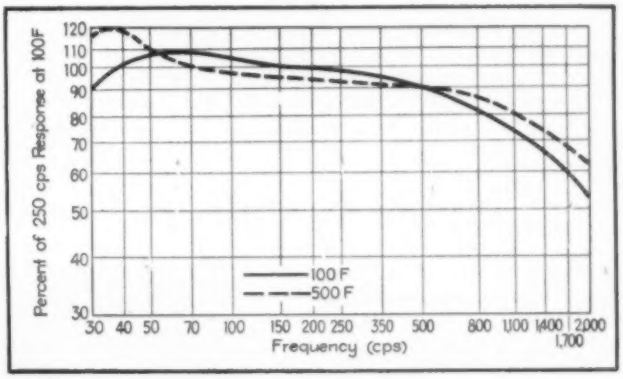
The velocity pickup operates as a miniature generator, producing a voltage proportional to the vibratory velocity of the structure on which it is mounted. Attached to the base and case is a high-flux permanent magnet, while traveling freely on the center shaft is a coil and seismic mass. The magnet follows every movement of the test structure, while the mass and coil tend to remain at rest. The relative movement between the two, cuts the magnetic lines of force and generates a voltage directly proportional to the case velocity, and to the vibratory velocity of the object or structure being tested.

The velocity measured by the pickup is a product of amplitude times frequency, therefore the voltage generated may be integrated electrically to give values of displacement, or electrically differentiated for values of acceleration. The damping effect of the instrument on the device under test is negligible compared to that of larger instruments. As it is insensitive to vibrations other than those directly along its axis, it can be used to isolate and measure movement in any one direction, and can be mounted in any position.

Specifications: Open circuit output: 100 mv/in./sec. at 250 cps, 100 F; Maximum amplitude: (a) 0.12 in. double amplitude, or (b) amplitudes produced by ±3g at 500 F and ±6g at 100 F; Natural frequency: 30 cps nominal; Impedance: 750 ohms (nominal) d-c coil resistance.

Consolidated Engineering Corp., 300 N. Sierra Madre Villa, Pasadena 8, Calif.





Frequency Computer for Flow-Measuring System

Used for the continuous measurement of flow of difficult fluids, a new frequency computer of a flow-metering system has a primary element which generates electrical pulses with a frequency proportional to the flow rate.

The computer may be operated with pulses as low as 1 millivolt in amplitude. Ranges of 5-100 cycles per sec and higher with an accuracy of ±0.5 percent full scale are available. An internal frequency reference gives overall system standardization.

The frequency computer can be made to measure directly the frequency of any source in the audio range; measurement of higher frequencies can be accomplished by using dividers. In addition to the flow meter application, the computer may be used as a tachometer, with a photo-electric or magnetic pick off; as a frequency deviation meter; or for any other applications where measure of frequency is required. The output is a d-c voltage suitable for use with indicating, controlling, and recording instruments.

North American Instruments, Inc. 3445 Cahuenga Blvd., Los Angeles 28, Calif.

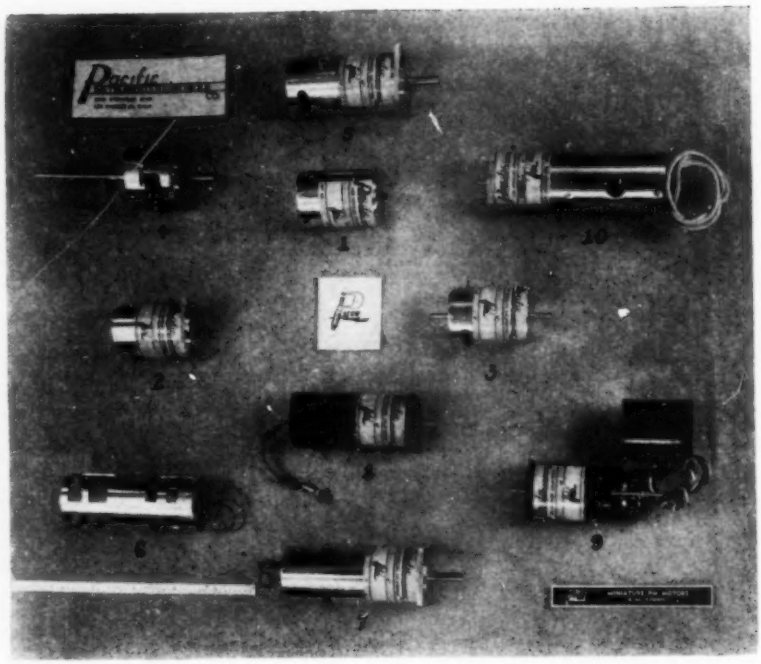
CONTINUED ON PAGE 242

Miniature Motors With Variety of Accessories

A complete series of PM motors for d-c service is now available in various adaptations and in combination with various accessories for use in servo systems, instrumentation gear, electronic equipment, actuators, switching devices, blowers, and other equipment in aircraft and naval applications.

The motors shown in the illustration show: (1) the basic motor in the round piloted form with pinion output shaft, (2) the same motor with square flange mounting, and (3) the round motor with double end shaft outputs. Figure (4) illustrates the gear unit which is available in the same size to a ratio of approximately 76000/1 and can be provided for various torque loads. Figure (5) shows the combination of motor and gear unit. Figure (6) illustrates a magnetic brake, and in figure (7) is shown the combination of motor-gear-and brake. Figure (8) illustrates an all-enclosed shielded motor while figure (9) shows a combination of motor and governor used for constant speed operation. Figure (10) illustrates a special form of the motor in combination with a governor speed signaling device.

All of the motors are 1¼ in. in dia., the accessories being built in unit type construction to fit inside the 1¼ in. dimension. The basic standard motor is 1¾ in. long, weighs less than 3½ oz., and is capable of a power output to approximately 15 watts at 27½ volts d-c. Various modifications of the motor are made available for power outputs to 25 watts, for various speed ranges, and supply voltages. In addition to those shown in the illustration, the motors are made available in various special forms and combinations to meet particular applications.



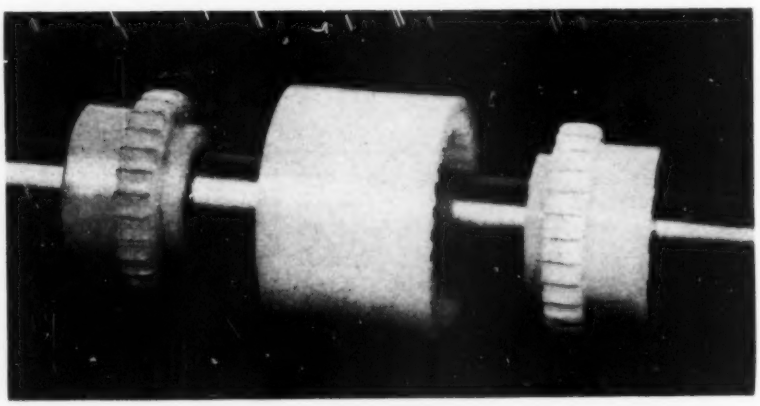
Pacific Instruments & Controls Co., 2315 Westwood Blvd., Los Angeles 64, Calif.

Nylon Couplings For Fractional Hp Drives

Weighing only 2¼ oz., a new gear type coupling for small fractional horsepower drives is available for nominal bores down to ⅜ in. in diameter.

Known as the Junior gear type coupling, it has two externally geared hubs enclosed in an internally geared sleeve that takes any size hub from ⅜ in. to ¾ in. bore. It is made of smooth Nylon, withstands corrosion, and is not affected by most liquids and gases. The junior coupling with a ¾ in. hub has been tested safely to 1,100 in.-lb. torque.

The coupling is completely molded and requires no machining, and contoured teeth take care of any misalignment of the shafts. It is water repellent, has no fiber inserts to wear out, and needs no lubrication.



John Waldron Corp., River Road, New Brunswick, N. J.

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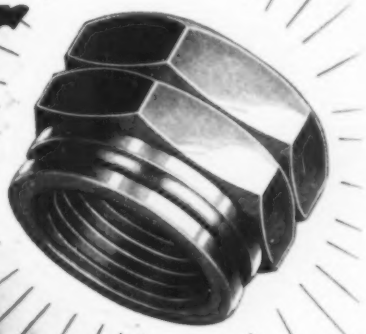
MORE AND MORE ENGINEERS ARE SPECIFYING

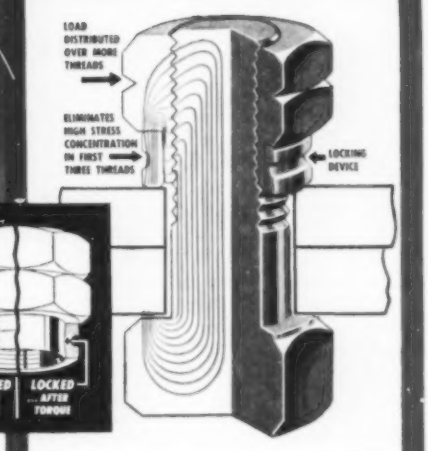
Klincher LOCKNUT

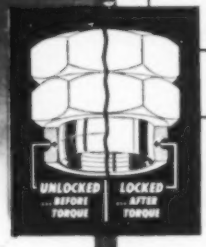


for High Temperature Fastening up to

1600°

. . . particularly where high frequency vibration, tensile strength and re-usability are factors!





On more and more vital bolt connections on jet and conventional aircraft engines, race cars, Diesel engines, and equally stringent applications, Klincher Locknut is getting first call. Engineers recognize that Klincher design characteristics reduce high stress concentration and torsional load usually found in the first two or three threads. Load is distributed to more threads. Result: you take advantage of all the strength designed in your bolt, stud or axle shaft.

Inquiries invited regarding specialized locknut problems. Write for data and experimental samples, giving size and application.

KLINCHER ADVANTAGES:

Spin freely down to work. Stays positively locked.

After breakaway, nut spins off freely, ready for reuse, without impairment of locking efficiency.

Only one piece to stock and handle . . . saves time installing and removing.

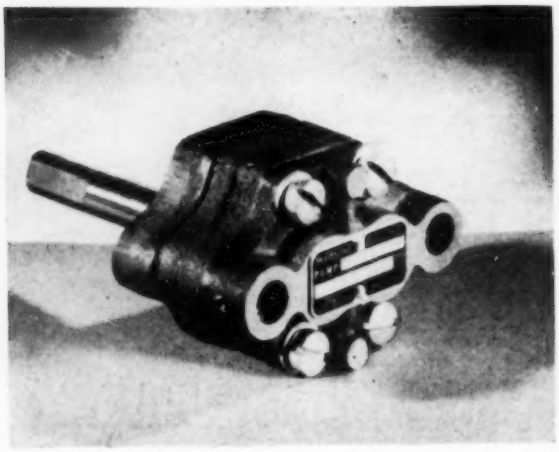
Ideal for standard and power wrenches.

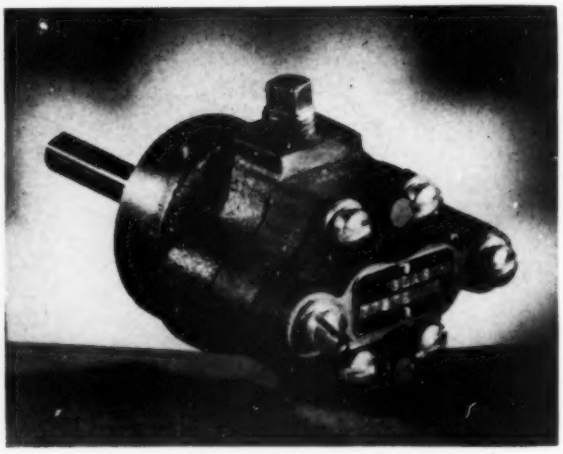
Manufactured in stainless steel and other materials.

INDUSTRIAL FASTENERS INSTITUTE

Klincher LOCKNUT CORP.

2153 HILLSIDE AVE. INDIANAPOLIS, INDIANA





Positive Displacement Gear Type Pumps

With both models available in five sizes, these new gear type hydraulic pumps have capacities ranging from ¼ to 2 gpm at 1800 rpm and 100 psi, with pressures up to 200 psi recommended.

Of the two models shown above, the one at left is the type LAP (Face or Wet Sump Mounting). The unit at right is the type LAS (Sealed Unit), and is identical to the type LAP pumps except for the addition of a shaft seal which permits them to be used with either direct, gear, or belt drives. Both of the models are also available as 115/230 V motor-pump combination units.

An internal relief valve is available which can be set between 50 and 200 psi, but cannot be used as a control or pressure-regulating valve.

Typical applications of the pumps include: pressure lubricating; oil circulating; oil filtering systems; oil transfer; replenishing systems; lift systems; and others. The design of the unit permits use in pumping other liquids having a substantial oil base.

The overall length of the largest type LAP pump, including the shaft, is about 5½ inches. Length of the type LAS pump is about 6½ in.; width is about 2¼ inches.

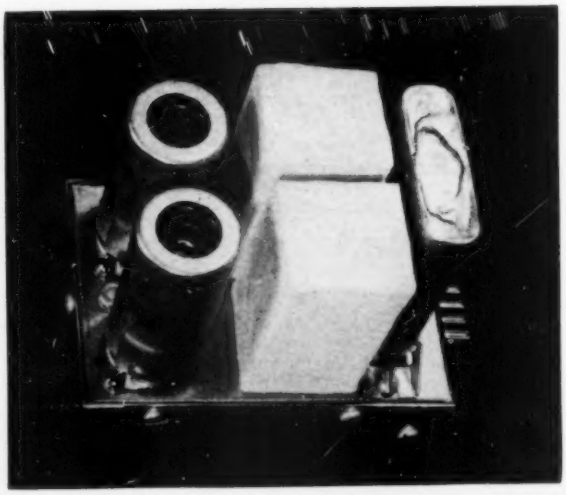
Webster Electric Co., 1900 *Clark St., Racine, Wis.*

Isolation Amplifier Has Improved Circuitry

By use of specially designed networks and a special amplifier circuit, an amplifier is now available that will give optimum performance with a variety of load conditions and operating frequencies. The new circuit has networks for controlling the amplifier response from 0.1 cps to 100 kc, permitting operation at any carrier frequency from 30 cps to one kc. This range includes all of the standard power frequencies and a number of the radar timing frequencies and meets a variety of design requirements with a single interchangeable plug-in unit.

The unit was designed primarily for use in driving resolvers and computing potentiometers. A high input resistance has been obtained by the elimination of the conventional input summing resistors. Up to 66 db of negative feedback gives almost complete independence from tube, power supply, and frequency variations. The networks for controlling the frequency response of the amplifier are molded in a thermosetting meterial for stability and simplified packaging.

Specifications for the unit shown are: length, 3.5 in.; width, 2.56 in.; height, 3.7 inches. Power requirements: are 6.3 volts at 0.6 amp.; 275 volts at 16 Ma.



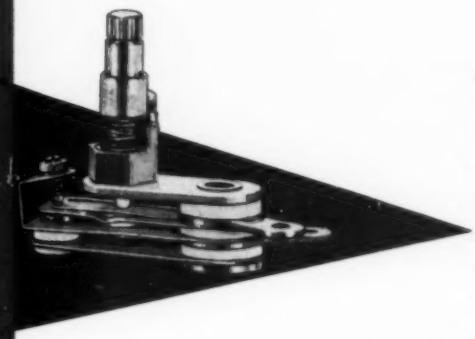
Seay Instrument Co., 6521 *N. Lamar Blvd., Austin 5, Tex.*

CONTINUED ON PAGE 246

If this is your product

this is your thermostat

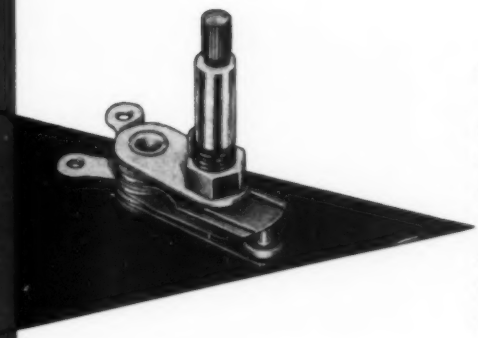
PERCOLATORS
FLAT IRONS
VAPORIZERS
FURNACE FANS
STEAM IRONS
STERILIZERS



TYPE SA THERMOSTATS

for sensitive, snap-action control characteristics. Operate on differentials as narrow as 10°F or on wide differentials up to 100°F. Available in adjustable *(shown)*, non-adjustable or manual reset (Type SM) styles. Also for single-pole double-throw operation.

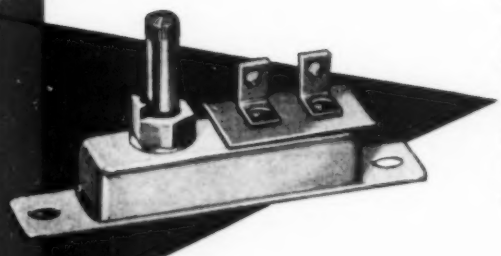
FLAT IRONS
IRONERS
WAFFLE IRONS
PERCOLATORS
INDUSTRIAL APPLIANCES



TYPE S THERMOSTATS

give clean, positive make and break. Single-stud mounting gives metal-to-metal contact with controlled device for faster bimetal response, closer temperature control. Available in adjustable *(shown)* and non-adjustable styles. Interchangeable with Type SA.

BUTTER WARMERS
RECTIFIER FANS
ELECTRONIC DEVICES
INDUSTRIAL APPARATUS
AVIONIC DEVICES
WATER TANKS



TYPE W THERMOSTATS

give snap-action make or break on temperature increase. They closely follow temperature of controlled device, respond rapidly to temperature changes, give sensitive, precise control of high-wattage heater loads, do not interfere with radio reception.

Appliances . . . radar . . . processing apparatus—if your product requires snap or positive-action temperature control, better get in touch with Stevens first. For Stevens application engineers are solving problems like yours every day.

And since Stevens makes the largest line of bimetal thermostats in the industry, there's a good chance that a standard Stevens thermostat will solve your special problem. This means a better break on price and delivery—and at the same time insures the performance and life of your product. A-6101

STEVENS ***manufacturing company, inc.*** **MANSFIELD, OHIO**

Arbor Motor For Heavy Duty Work

Called the type SRP Arbor Motor, this unit was designed for use in the woodworking and machine tool industry to provide a motorized arbor with a minimum diameter and rigid construction for the purpose of carrying directly on its shaft such tools as saws, cutter heads, and grinding wheels. It is available with the conventional straight motor shaft, saw collars as illustrated, or any shaft modification. The arbor motor is normally rated 55 deg. rise for continuous duty operations, but for applications where the motor will be operated or loaded intermittently, it is given a 55 deg. 1 hour rating in a smaller frame size. The motor is totally-enclosed fan-cooled having single end ventilation. The ventilating fan is located at the front end of the motor opposite the shaft extension. Good cooling is obtained by passing this air over the entire distance of the outside notched stator.

The motor is built in two diameters: the 600 series covering ratings of 3, 5, and 7.5 hp continuous at 3600 rpm; and the 800 series covering ratings of 7.5, 10, and 15 hp continuous at 3600 rpm. One flat side can be provided on the motor and this flat side may be located on the top or either side giving a distance of 3¼ in from the center line of the shaft to the flat side on the 600 series, and 4¼-in. on the 800 series motor. In saw work, this feature permits the use of a smaller diameter saw and gives longer saw life due to increased usable saw diameter.

The motor has a rigid shaft to hold shaft deflection to a minimum, and the unit is given precision balance for high quality work. All of the motors are balanced to the degree of 0.0002 in. on the 600 series and to 0.0003 in. on the 800 series. For conventional saw work, the standard unit has single row bearings slightly preloaded. But for applications having strong end thrust or unusually high radial load, the shaft extension end may be fitted with a double row or duplex bearing.

To increase the rigidity, the conventional housing has been eliminated and the feet of the motor are located on the end bells in order to be as close as possible to the point of bearing support. The feet are located inside the minimum width dimension of the end bells and have drilled and tapped mounting holes. The bearing housing at the saw end is extended to permit mounting of any attachments.

The motor can be obtained with a tite bite connector for single voltage leads or if dual voltage is necessary, the conventional conduit box may be supplied. The leads are brought out opposite the feet or either side of the motor.

The Louis Allis Co., 427 E. Stewart St., Milwaukee 7, Wis.

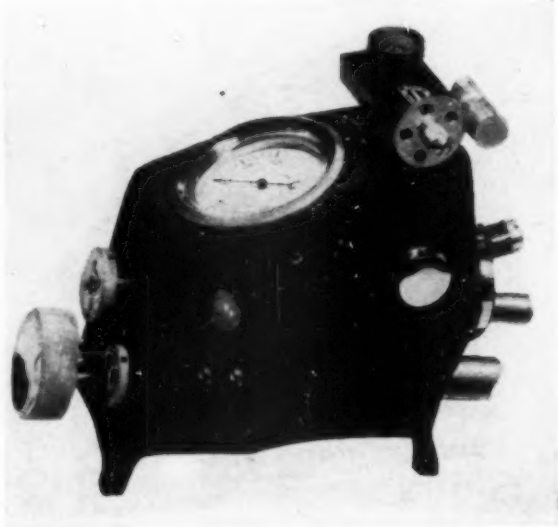
Portable Hardness Tester For All Metals

The penetrascope, a new portable metal hardness testing instrument, tests ferrous and non-ferrous metals in a wide range of sizes and shapes. The tester may be used on large or small work in place, or on jobs in the shop or laboratory.

A variety of standard clamps, electro-magnetic, chain and C-clamps, are available, and others can be designed for special applications. The manufacturer claims that a special combination of the penetrascope and an electromagnetic stand can test many normally inaccessible parts of large assembled or partly dismantled units.

The penetrascope has a 136 deg. pyramidal diamond indentor that makes a small impression under controlled load, and the diagonals of the impression are measured within an accuracy of 0.001 millimeter.

The load on the diamond indentor can be set at any point from one to 30 kilos to suit the hardness of the metal being tested. Ball type indentors of one millimeter and two millimeter diameters are supplied for testing cast iron and other large grained metals. More information on this tester may be obtained from the manufacturer.

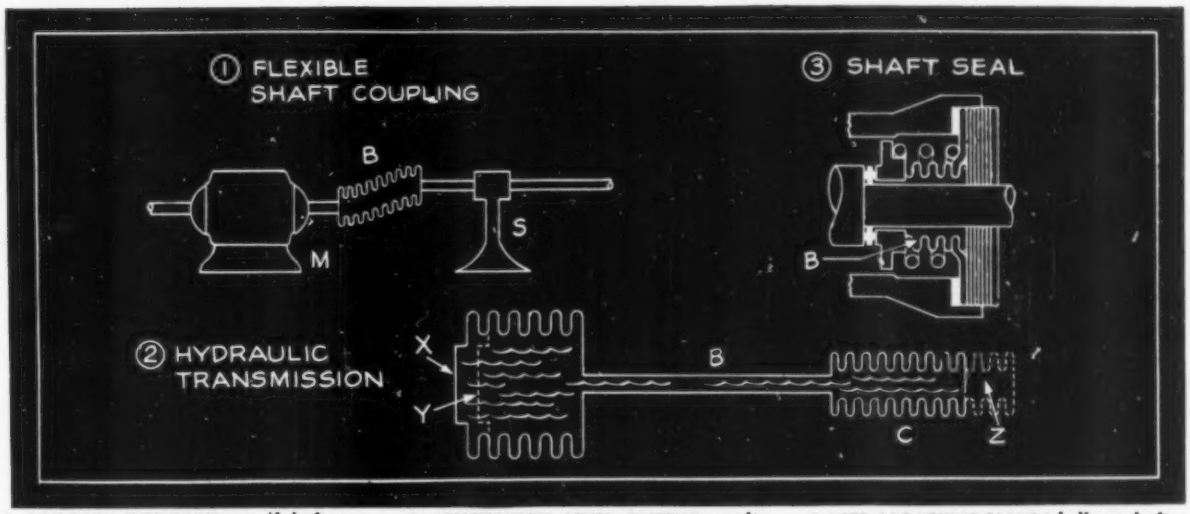


C. Tennant, Sons & Co., 100 Park Ave., New York 17, N. Y.

CONTINUED ON PAGE 248

Bellows Digest

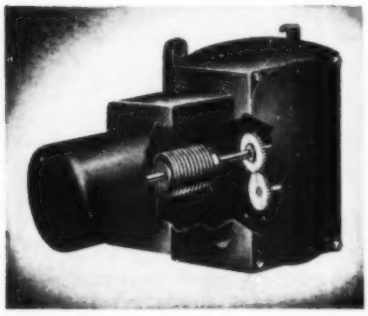
No. 6. Bellows used for Flexible Shaft Couplings, Hydraulic Transmission and Shaft Seals.



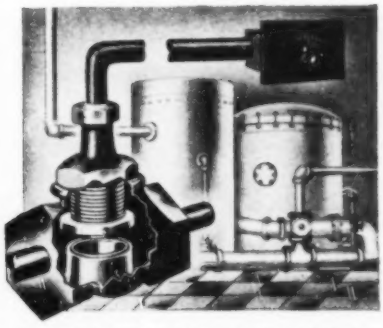
1. A SMOOTH, EVEN DRIVE even if shafts are misaligned is one of the major advantages of bellows shaft couplings over ordinary flexible couplings in many applications. Bellows (B) on driving shaft of small motor (M) transmits true, constant velocity to driven shaft (S).

2. "FRICTIONLESS LEVER SYSTEM" results when liquid filled bellows system is used in transmitting force. Large force at (X) moving large bellows through short distance (Y) is transmitted through tube (B) to small bellows (C), moving it through long distance (Z). Action may be varied or reversed by changing bellows sizes.

3. USED AS PACKING GLANDS, bellows shaft seals (B) prevent leakage of enclosed fluid around rotating shafts. All metal construction makes bellows ideal where seals are required to resist gases, corrosive liquids and extreme temperatures. Pressure on seal surfaces can be kept constant, regardless of a system's varying pressures.



SERVO MECHANISMS are typical applications benefited by the constant velocity drive and ease of alignment assured by Clifford bellows used as flexible couplings. Another big advantage over conventional couplings is the time-and-money-saving elimination of the need for precise alignment of motors and shafts.

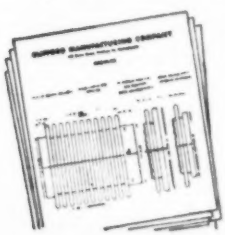


REMOTE CONTROL OF FLUID FLOW, in many types of processing equipment, is here provided by a Clifford bellows system. Valve in cutaway view is remotely controlled by liquid-filled bellows assembly governed by knob on control panel. Principle of hydraulic transmission of pressure can be used in wide variety of controls.

IN AIR CONDITIONING UNITS, where prevention of refrigerant gas leakage is vital, seals on compressor shafts must be leakproof and impervious to gases. That is why leading manufacturers of air conditioning equipment select Clifford bellows shaft seals for this important purpose. Seal surfaces can be finished to a flatness of five micro-inches.

MAYBE YOU, TOO, CAN BENEFIT from the use of Clifford Hydron Bellows assemblies. Besides their use as flexible shaft couplings, shaft seals and in hydraulic transmission, these flexible, leakproof, metallic bellows are also used to: (1) control and indicate pressure and temperature; (2) provide for thermal expansion; (3) transmit motion from one medium to another; (4) provide shock mountings or vibration dampening; (5) permit motion in a vacuum.

Write Clifford Manufacturing Company, 122 Grove Street, Waltham 54, Massachusetts. *Division of Standard-Thomson Corporation.* Sales offices in New York; Detroit; Chicago; Los Angeles; Waltham, Massachusetts.



FREE! BELLOWS TEMPLATE KIT

Trace 20 most popular bellows sizes . . . fast . . . accurately. Kit, in handy cardboard envelope, includes full directions and details of Clifford bellows, simplifying tedious jobs — send for your kit today!

38-2-11

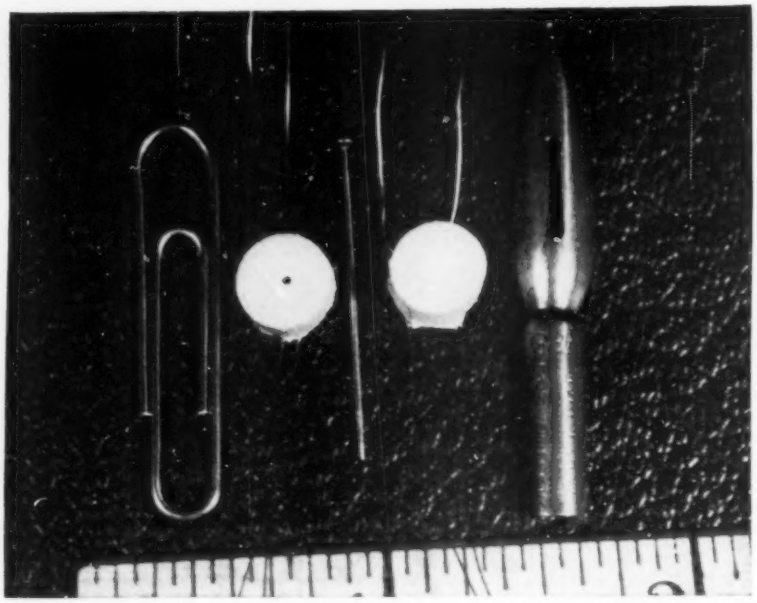
HYDRON METAL BELLOWS — CLIFFORD MANUFACTURING CO. WALTHAM, MASS. DIVISION OF STANDARD-THOMSON CORP. — HEAT EXCHANGERS

Potted, Subminiature Pulse Transformers

Claimed to be the smallest transformers in existence, they are designed for use with electrical pulses, and have such applications as digital computers, radar, telemetering systems, and pulse-type radio communication systems. The plastic cylinder containing the transformer is cylindrical in shape, measures $\frac{5}{16}$ in. in dia., $\frac{1}{8}$ in. thick, and weighs 1/100 oz., complete. For purposes of protection, the plastic cylinder is made of temperature resistant, thermosetting plastic.

The standard pulse transformers have two windings with a 1:1 turns ratio, but a different number of windings or other turns ratios are available. The windings are brought out of the transformer in 32-gage leads. The two transformers shown are alike electrically; the only difference is that model A1413 has an axial hole through which a mounting pin fits. This mounting pin can be pushed through a hole in any panel and secured by a drop of solder on the back of the panel.

By applying a square pulse to the primary through an input resistor, the following characteristics were obtained: Pulse length, one microsec; Input resistor, 50 ohms; Rise time, 0.1 microsec; Percent Fall, 10. With a pulse length of 5 microsec, and a 200 ohm resistor, the rise time is 0.1 microsec, and the fall is 50 percent. With these small units, the maximum permissible potential difference between windings is 1,000 volts.



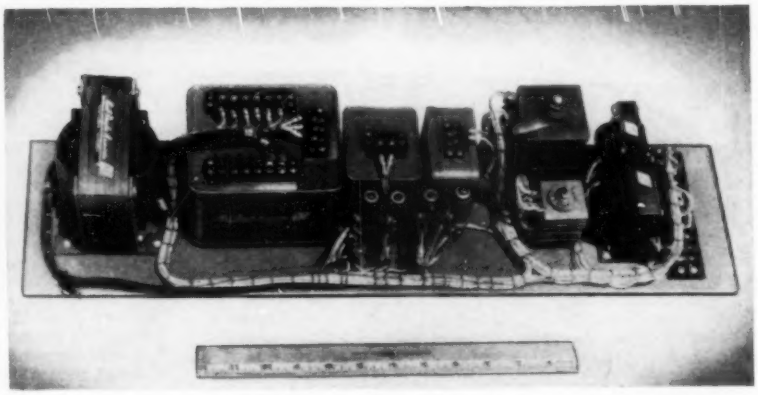
The Jacobs Instrument Co., 4718 Bethesda Ave., Bethesda 14, Md.

Magnetic Amplifiers For Accurate Current Control

A new line of magnetic amplifiers, devices for the precision control and amplification of a-c, perform the functions of present vacuum tube or motor-type regulators, but are said to have important advantages over these types.

They are efficient, and immune to both shock and vibration, can be mounted anywhere, and will last indefinitely, according to the manufacturer, since they contain nothing that will wear out or burn out. In many cases, they are smaller than comparable vacuum tube circuits. A special plastic potting compound protects them from heat and cold, high humidity and fungus, and has maximum dielectric strength and good heat transfer.

These magnetic amplifiers can be operated from any single or polyphase a-c supply voltage, varying from a few volts to several hundred, and at frequencies ranging from the lowest power frequencies to megacycles. Under certain conditions amplifications of 1 to 1,000,000 are possible.

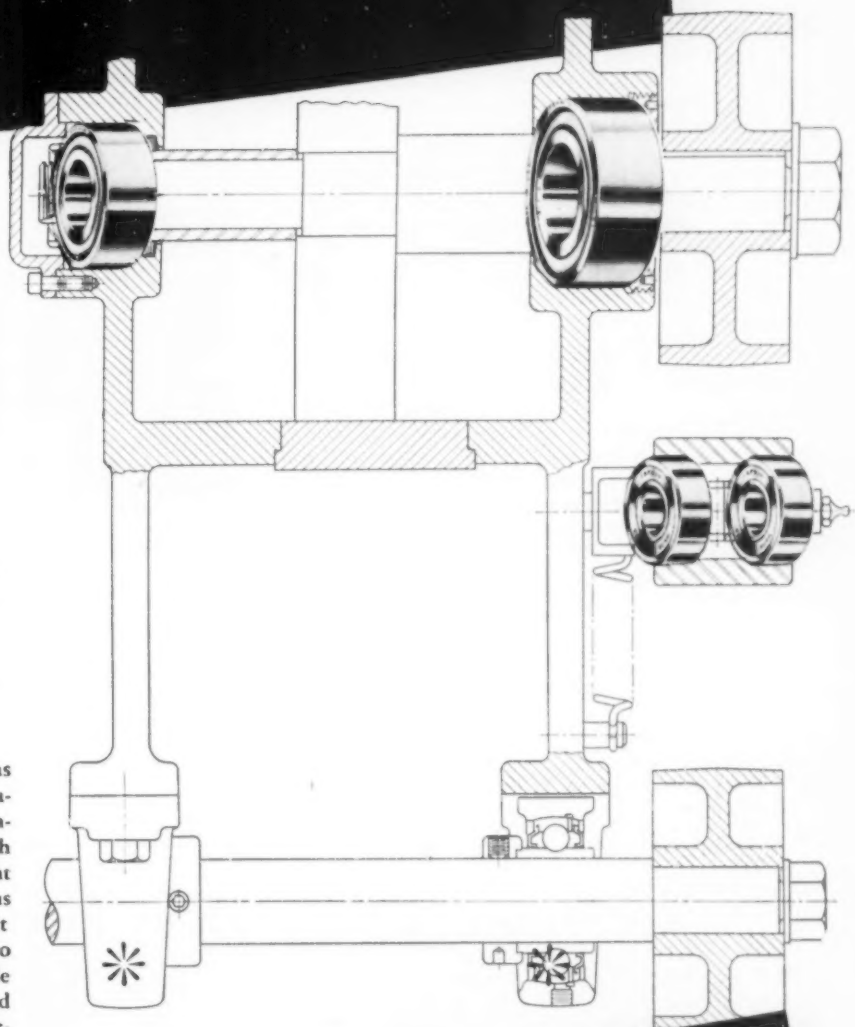


Present uses include control and positioning of variable speed motors of all sizes, from fractional to the very large motor drives (within ±1 percent), and regulation of both a-c and d-c generator voltage.

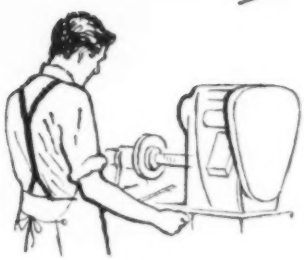
Karl-Douglas Associates, 3160 W. El Segundo Blvd., Hawthorne, Calif.

CONTINUED ON PAGE 250

GOING STEADY...for 16 years



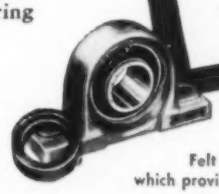
Arbor Spindle Assembly on Polishing Machine



In 1937, this arbor spindle was constructed and put into operation. It has been running constantly since then . . . through World War II and the present Defense Era. By means of various pulley and belt combinations, it has a speed range from 585 to 10,000 r.p.m. on the arbor spindle pulley. The assembly is equipped with grease-lubricated ball bearings . . . none have been replaced.

Maintenance problems were practically eliminated by the careful selection and arrangement of the right bearings on this installation . . . and the assembly's service life was extended materially. Here is a typical example of the Fafnir "attitude and aptitude" . . . a way of looking at bearing problems from the user's viewpoint, an aptitude for coming up with the precise bearing to fit the need. Maybe this combination can help you find a better, cheaper way to use bearings. The Fafnir Bearing Company, New Britain, Conn.

FAFNIR
BALL BEARINGS
MOST COMPLETE LINE IN AMERICA



***Fafnir Standard Duty Pillow Blocks** incorporating Fafnir Wide Inner Ring Bearings with Mechani-Seals are used in addition to Fafnir Felt Seal type Ball Bearings and Fafnir Double Row Bearings which provide increased axial and radial rigidity in limited space.

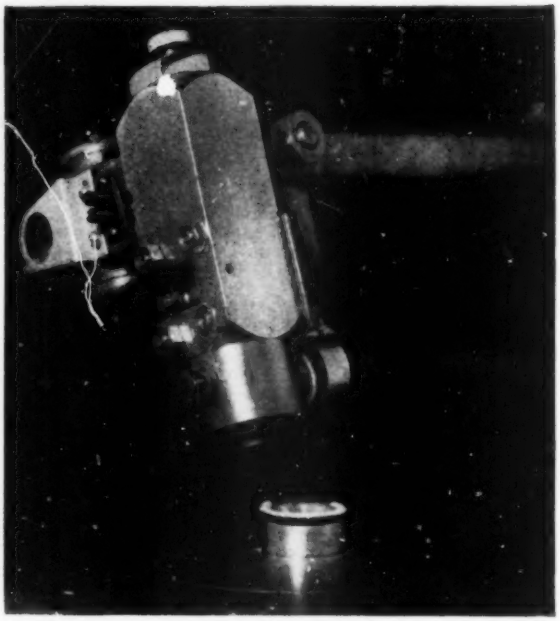
Flow-in Gaskets Automatically Applied

A new type gasket, which is said to provide an improved seal at lower labor and material costs, is now being produced as a replacement for conventional pre-cut cork or rubber gaskets, and can be used in a variety of manufacturing industries where component parts require gaskets.

Called the "flowed-in" gasket, it is applied as a liquid, synthetic rubber or resin compound, forced through a nozzle onto a spinning component part and then baked to form a solid rubbery gasket which will not fall off the part. With this method, the gasket can be applied either automatically or semi-automatically, depending upon the lining equipment used, and in varying types, thicknesses and diameters.

The manufacturers claim that the chief advantages over conventional precut gaskets are lower material cost; faster application, since the gasket does not have to be crimped, stamped or glued to hold it in place; better sealing qualities; decreased material ordering and stocking since one compound often will replace more than one type of pre-cut gasket.

Specially formulated compounds can be made to give effective seals against: moisture, oils, gasoline, many solvents, heat, pressure, vacuum, weather and vibration. Also compounds can be made to produce either cellular or solid gaskets as well as gaskets which swell to give hermetic sealing of an enclosed seam.



Application equipment is automatic or semi-automatic. On the automatic lining machine, which can apply gaskets at speeds up to 300 parts per minute, depending upon size of parts to be lined, the parts are belt or gravity fed to the machines and then to the chuck. The chuck spins the part under an adjustable nozzle which squirts a measured amount of compound into a groove or channel on the part. The lined part then moves off onto a conveyor belt to an oven where it is baked. The machine handles parts from $\frac{3}{4}$ in. to 12 in. in diameter. If belt-fed, high speed equipment is used, and no operator is necessary.

On the semi-automatic machine, the part is manually placed on the chuck. The machine requires a single operator, has a capacity of up to 50 parts per min. depending upon the size of the part, and will line parts measuring from $\frac{1}{2}$ in. to 23 in. in diameter. Baking time depends on the type of compound used and the size of the gasket.

Dewey & Almy Chemical Co., Cambridge, Mass.

Electrostatic Charges Easily Located

Weighing less than 4 lb. and containing its own source of power, this portable electrostatic locator gives an indication of the amount of electrical charge on moving or stationary equipment or materials, and is being used in the processing of textiles, rubber, chemicals, paper, and a variety of other materials.

The instrument has high sensitivity with provision made to permit the reduction of sensitivity to one-tenth or one-hundredth. Full sensitivity is used for general area inspection, and the lesser sensitivities permit close examination without sending the meter off-scale. Technically trained personnel are not required to make the tests.

Those parts of the instrument most likely to be affected by moisture and dust are sealed in. Power is supplied by a standard flashlight cell requiring replacement every 6 months, and by two standard $4\frac{1}{2}$ V dry cell batteries which, in normal usage, require replacement once a year.

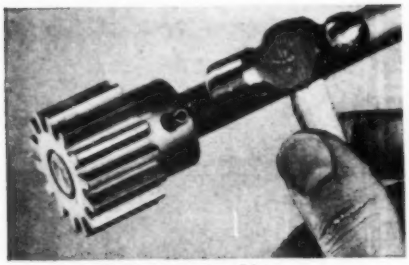
Specialties, Inc., Skunks Misery Rd., Syosset, Long Island, N. Y.

CONTINUED ON PAGE 252

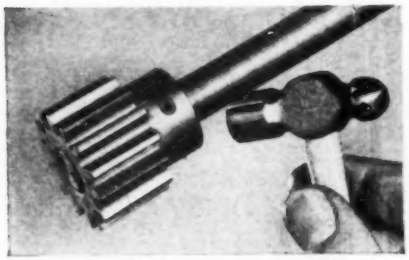
Where can you use this simple fastener?

Rollpin is driven into holes drilled to normal production-line tolerances.

No threading, peening or precision drilling with ROLLPIN



It compresses as driven.



Rollpin fits flush . . . is vibration-proof.

Rollpin is the slotted tubular steel pin with chamfered ends that is cutting production and maintenance costs in every class of industry.

This modern fastener drives easily into standard holes, compressing as driven. Its spring action locks it in place—regardless of impact loading, stress reversals or severe vibration. Rollpin is readily removable and can be re-used in the same hole.

* * *

If you use locating dowels, hinge pins, rivets, set screws—or straight, knurled, tapered or cotter type pins—Rollpin can cut your costs. Mail our coupon for design information.

Elastic Stop Nut Corporation of America
Dept. R-16-42, 2330 Vauxhall Road, Union, N. J.
Please send me the following free fastening information:

☐ Rollpin bulletin
☐ Elastic Stop Nut bulletin
☐ Here is a drawing of our product. What fastener would you suggest?

Name_____ Title_____

Firm_____

Street_____

City_____ Zone_____ State_____

Single Disk Clutch For Light Machinery

Specifically designed for light machinery service up to 6 hp, the models 350 and 450 single disk clutches use the same floating disk principle used on the Maxitorq clutch, also made by this company. The disks ride free in neutral, consequently there is no drag, abrasion or heating. Adjustment is made by tightening the knurled adjusting ring.

Used for dry operation only, several driving combinations are available including V-belt. These units are designed for use with either single or double grooved sheaves. The clutch with a gear tooth type drive may be used where the driven member is mounted on anti-friction bearings or otherwise restricted so that no axial movement along the shaft can take place. The bolted plate type drive combination can be used when the clutch is to be bolted to the driving member such as a gear, sprocket or sheave which can float slightly axially along the shaft. Both pulley type hub adapters and cut-off coupling type adapters may be used with these drives.

The model 350 clutch is rated at 3 hp, and the 450 at 6 hp. Typical applications are: hoists; loaders; pumps; air compressors; conveyors; and medium farm machinery.

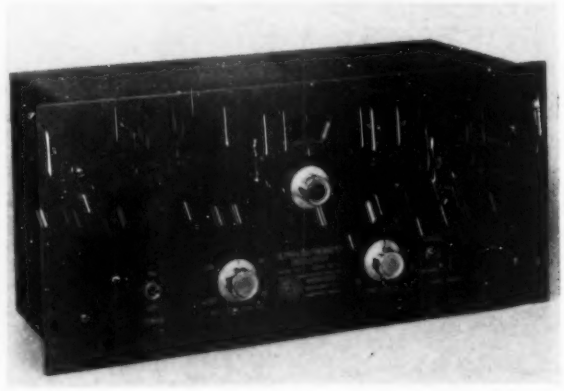
The Carlyle Johnson Machine Co., Manchester, Conn.

Ultra-Low Frequency Oscillator For Testing Servos

An ultra low frequency oscillator that simultaneously provides both sine and square-wave voltages at any frequency between 0.009 and 1,100 cps has been found to be particularly useful for the designing and testing of servo mechanisms, for geophysical and seismological instruments, for feed-back amplifiers, vibration checks, and in conjunction with timing and production controls.

Known as the model 400-C, its sine wave output may be used either balanced or single ended, with the maximum output 30 V peak to peak across a 1,000 ohm load. The square wave is also useful for low frequency switching and triggering operations, and for frequency or transient response measurements.

Special circuitry to eliminate tuning and hand-switching transients have also been installed. Other features are: low hum and distortion; good amplitude over the entire frequency range, a single scale logarithmic dial with a vernier tuning control, and low input power. The dimensions of the new oscillator are 19 in. by 8¾ in. by 7½ inches.



Krohn-Hite Instrument Co., 580 Massachusetts Ave., Cambridge 39, Mass.

A COMPLETE LINE OF VINYL adhesives is now being use for bonding vinyl plastics to themselves and to wood, metal, glass, acrylic plastics, cloth, and other substances. These vinyl adhesives are said to be easy to apply and do not require heat, pressure, nor any special surface preparations. Cement #201 consists of several strong solvents and penetrants, and was developed specifically for bonding vinyl film to itself. Although fast acting, this material produces a minimum of curl on thin film, but still produces a strong bond. Cement #203 is an adhesive for bonding vinyl plastics to metal, glass, paper, leather and other surfaces. It produces a quick initial bond and is fast setting. This is a bodied adhesive and applied by brush, machine, or other methods. Chemical Development Corp., Danvers, Mass.

HAVING HIGH DIMENSIONAL STABILITY, low dielectric loss, immunity to high temperature and humidity exposure, and maximum mechanical strength are the features of a line of new transistor sockets. The loss factor is 0.014 at 1 MC and the dielectric strength 400 volts/mil. Contacts are brass or beryllium copper, and the sockets are solderable. Mycalex Tube Socket Corp., 60 Clifton Blvd., Clifton, N. J.

CONTINUED ON PAGE 254

You find the piping data you need ...In the Complete CRANE Catalog

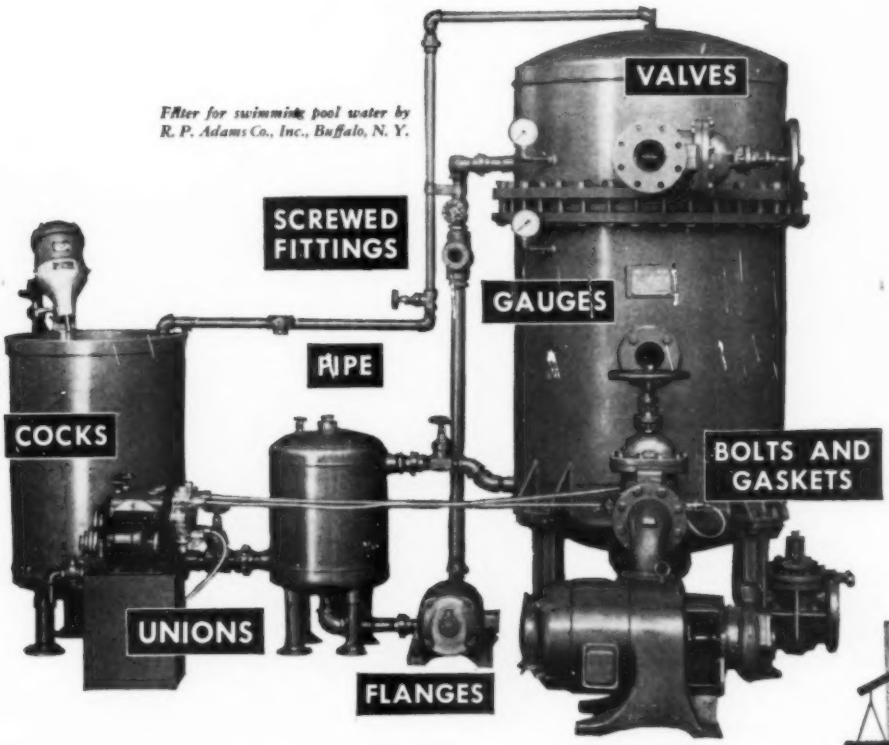
For designer's choice in valves, fittings, accessories and piping specialties, always turn to your complete Crane Catalog. It's fully indexed, easy to read, and gives you *all* the specifying information you normally need—sizes and dimensions, pressure and temperature ratings, plus details on design, materials and construction. And if you want basic flow engineering data, that's in your Crane catalog, too.

All this, of course, helps you save time and effort in writing piping "specs." But there's another important advantage to be gained by specifying Crane. And that's in the service your product delivers. Machinery buyers prefer Crane equipment for its greater efficiency and dependability.

YOU ADD QUALITY TO YOUR DESIGN WHEN YOU SPECIFY THE CRANE PIPING LINE

BIG FAMILY OF IRON VALVES

In 125-Pound Wedge Gates, for example, Crane meets every need of steam, water, oil, or gas. Brass-trimmed or all-iron, these valves are available in Non-Rising Stem, O. S. & Y., Underwriters', and Quick Opening patterns. Screwed, flanged or hub ends.



Filter for swimming pool water by R. P. Adams Co., Inc., Buffalo, N. Y.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

Gaging Comparator Has Four Ranges

Taking the place of four ordinary, single-range comparators, a new line of electrical comparator gages permits the testing of parts in any one of four ranges best suited to their tolerance. For example, model 10 has full scale ranges of plus-or-minus 0.000020 in., 0.000040 in., 0.000200 in., and 0.000400 inch. In the 0.000020 in. range, each meter division has a value of 0.000001 in., and parts can be checked to a millionth. On the 0.000400 in. range each meter division has a value of 0.000020 in. so that parts can be checked to within 0.000020 in. when closer readings are not required. Two other ranges are available between the limits of the above two.

The new comparators use the electro-magnetic principle of magnifying the movement of the spindle tip. Vacuum tubes or mechanical linkages are not necessary so that longer instrument life can be expected. The electromagnetic principle of magnification is said to have good stability, enabling the comparators to give consistent readings. There are no frictional moving parts in the gage head.

Spindle pressure in the new models is adjustable from four to forty ounces, and is set by means of a knob and associated calibrated dial. A spindle lifter is supplied to aid in the checking of very small or delicate parts. Spindle tips are of long wearing boron carbide. The gaging head swivels 360 deg. in both horizontal and vertical planes, and can be removed for use in special gaging setups or in remote indication setups.

The standard comparator models in the new series have a gaging capacity of 6½ in. maximum height, and a 4 in. depth. A special long column is available which has an effective checking height of 20 inches. Comparators calibrated according to the metric system can also be supplied.

A line of accessories has been designed for use with the comparators to increase their range of application.

The DoAll Co., 254 N. Laurel Ave., Des Plaines, Ill.

Pressure and Scavenging Lubricating Pump

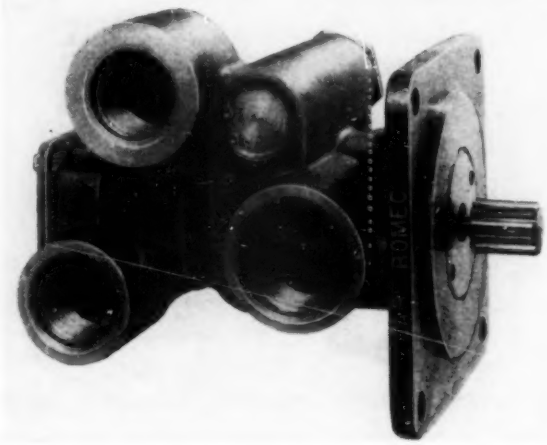
Specially designed for gas turbine lubrication, a 3-element pump gives complete lubrication through a combination of one pressure and two scavenge pump elements assembled in a single unit.

The lube pressure element is used for supplying oil to the engine bearings with a rated capacity of 9 gpm at 50 to 60 psi and 3360 rpm. It has a 0.885 cu. in./rev displacement, and is equipped with an adjustable relief valve, with the excess oil pumped by-passes internally to inlet side.

The scavenge pumps are located in line with the lube pump; the 4 gpm scavenge element in the center, and the 1.5 gpm scavenge element at the end opposite the drive end. They have a displacement of 0.309 and 0.115 cu. in./rev respectively. All porting of the pump is external and is arranged so elements may scavenge oil from separate locations and discharge it back to the reservoir through a [illegible] line.

[illegible] design of the bore is said to give a smooth common [illegible] in a rotary vane, positive displacement

A special [illegible] 1 1/16-12N3 straight thread for ¾ in. non-pulsating flo[illegible] lubricating oil inlet port which is pump. All ports a[illegible] for a one inch tube fitting. tube fitting, except the [illegible]on viewing the driving end 1 5/16-12N-3 straight thread[illegible] Rotation is counter clockwise [illegible]



of the pump. Total weight of the unit is 5 pounds. More information may be obtained from the manufacturer.

Lear Inc., Romec Div., Elyria, Ohio

CONTINUED ON PAGE 256

CHASE WIRE can help keep your production costs down

You cut down rejects when you use Chase Brass and Copper Alloy Wire.

Chase mills inspect every coil of wire produced. No scratches, no slivers, spills, or laps! Chase wire is of uniform temper and grain size, uniform in surface texture and color, accurate in gauge. It comes to you clean and bright.

Chase wire is available in a wide variety of alloys, shapes, sizes and tempers.

Write today for free folder "Chase Cold-Heading Extruded Brass and Copper Alloy Wire."

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Boston	Detroit	Minneapolis	Providence	
Chicago	Houston	Newark	Rochester †	(† sales
Cincinnati	Indianapolis	New Orleans	St. Louis	office only)

Time Totalizer Measures Elapsed Time Intervals

Used for precise measurements of elapsed time intervals, a new type ET time totalizer is available in two models. One has scale divisions of 0.01 sec. and a total range of 60 sec., and the other has divisions of 0.01 min. and a total range of 60 minutes. Accuracy for either is better than 0.2 of one percent. Possible applications as timing operations in industrial laboratories, or for measurement and control of processes in the chemicals or metals industries.

Feature of the new time totalizer is a differential clutch mechanism having accuracy and positive clutching. Instead of the conventional friction of face plate clutch, the motor is permanently connected to the sun gear of a differential gear system. One of the differential members is connected to the pointer system, while the other goes to a free gear.

When the timer is energized, a solenoid-operated pawl stops the free differential member, and power is transferred to the pointer differential member. When the timer is de-energized, a pawl engages the pointer gear, stopping it, while the free differential member is simultaneously released, allowing it to rotate free. This arrangement is said to give positive, accurate clutching without the slippage or over-run characteristics of friction type clutches.

Other features of the new design are a compact meter-type housing, making it applicable for panel installation or where space is limited. The high-torque synchronous motor is used as a driving source to provide adequate reserve power for adverse operation conditions.

Forms of this time totalizer are available to meet the military specifications with regard to shock, vibration and temperature. This, together with the small size of the unit permit its application in mobile and airborne equipment.

R. W. Cramer Co., Centerbrook 5, Conn.

NOW AVAILABLE IN FOUR MODELS, small, hermetically sealed diffused junction germanium rectifiers may be used in computers, magnetic amplifiers, television receivers, and telephone switch boards. Forward resistance is less than two ohms at rated load. Peak inverse voltage range from 100 to 400 volts. Output direct currents into a resistive load range from 75 to 500 milli-amperes. Full load voltage drop is 0.5 in three models and 0.7 in the fourth. All ratings are at ambient temperature up to 55 C. General Electric Co., Electronics Park, Syracuse, N. Y.

DESIGNED PARTICULARLY FOR USE in the instrumentation and electronics field, miniature hexagonal stop nuts, as small as 0.109 in. across flats, have nylon locking inserts, and are available in brass and aluminum. The nylon locking insert maintains a constant, reusable grip on screw threads, and is unaffected by vibration. Possible uses include applications in optical instruments, hearing aids, cameras, medical instruments, and clocks. The miniature nuts, type 1660, are being made in sizes zero through no. 4, and are available in both NC and NF threads. Elastic Stop Nut Corp. of America, 2330 Vauxhall Road, Union, N. J.

A NEW SERIES of microwave signal sources covering the frequency range of 634 to 10,750 mc in five units use a reflex Klystron as a source of microwave energy. Frequency can be read directly to 10 percent accuracy. A single dial controls cavity frequency and reflector voltage. Modulation inputs for the signal sources is available on the front panel. High stability and durability are some of the features. Polarad Electronics Corp., Metropolitan Ave., Brooklyn 11, N. Y.

A DIRECT-READING, 24-hour clock reads from 0001 (one minute past midnight) to 2400 (midnight), and has five drum dials: ten-hour, hour, ten-minute, minute, and second. The minute dials have black numerals on white background, and the second dial has four different color sectors, with black numerals. The register starts to clear at 25 seconds after midnight, and indicates 0001 at one minute past midnight. Uses synchronous, self-starting motor that consumes 3 watts; for 115v, 60 cycle operation. Measures $4\frac{13}{16}$ in. high, $7\frac{7}{16}$ in. wide, $4\frac{1}{2}$ in. deep. All parts of brass, aluminum, or stainless steel. Can be supplied in parallel for operation on low voltages. Wickes Engineering & Construction Co., Camden, N. J.

IN THE FORM OF A FREE-FLOWING, viscous liquid, a new plastisol is converted into a flexible rubber-like coating with the application of heat. Known as Cycloflex No. 7731, and meeting Army Ordnance Specification, the coating can be furnished from $\frac{1}{32}$ to $\frac{1}{2}$ in. thick, and will replace rubber or rubber bonded coatings. The coating has good resistance to: oils, greases, acids, alkalies, salts of inorganic acids, oxidation, as well as petroleum solvents. Coatings will not harden, check, or craze on aging. It meets the —45 F, fungus resistance, and other requirements. Munray Products, Inc., 12400 Crossburn Ave., Cleveland 11, Ohio.

CONTINUED ON PAGE 258

A new achievement in the science of bearing design
THE
BEARING

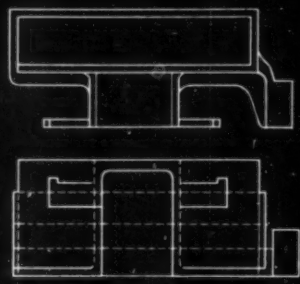
WANTED:
closer tolerances reduced costs

SUGGESTED - BRUSH HOLDER

General Electric Co.,
Small Motors Division,
Lynn, Mass.

Att: DESIGN ENGINEERING

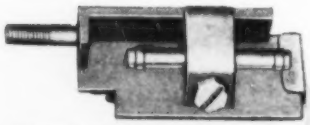
.076 MIN. WALL



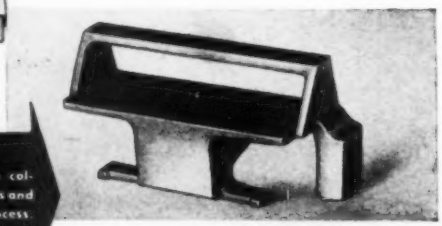
This design is the best from production standpoint
We could produce it to reflect credit
on both companies. E.B. Atlantic Casting

The production of a light weight, rugged brush holder for use with aircraft generators posed a problem for General Electric. They wanted a high-quality, rigid brush holder at reduced cost, produced by a process that afforded closer control of tolerances.

Atlantic was consulted and the recommendations they made on the brush holder design provided more than ample strength. The Atlantalloy process provided the close tolerances and lower cost.



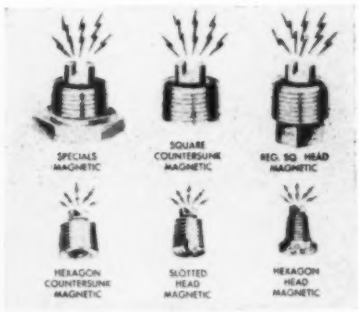
Old brush holder designed by General Electric for use on aircraft generators.



New brush holder designed in collaboration with Atlantic engineers and produced by the Plaster Mold Process

WRITE for a copy of "Quality Precision Castings for Industry" on your Company letterhead. This booklet explains how the plaster mold process cuts production costs, and includes specifications on Atlantic's alloys.

CASTING and ENGINEERING CORP.



Magnetic Pipe Plugs For Oil Lines

Magnetic pipe, drain and filler plugs, ranging in sizes from $\frac{1}{8}$ to 2 in. are made to original equipment standards in such styles as: square heads; square countersunk; hexagon counter sunk; slotted; hexagon head; and specials and are made in such materials as: cast iron; steel; malleable; brass; aluminum; and stainless. All the plugs are threaded Dryseal to eliminate leaking.

The magnetic plugs attract abrasive, ferrous particles, directly from the oil or lubricant stream, in addition to the particles that normally settle out.

The plugs are made of sintered, permanent alnico magnets, are interchangeable with common pipe or drain plugs, and are effective in any lubricant or hydraulic system.

Magnetic Drain Plug Co., Wellington, Ohio

Positioner For Cylinder Operated Devices

Operating from a standard 3-15 psi pneumatic controller signal, a device known as the poweractor positioner applies a high pressure, pneumatic differential across a cylinder piston, sufficient to produce the position demanded by the controller.

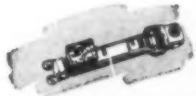
Designed particularly for use with the Stabiload cylinder made by this company, the Poweractor unit will position equipment requiring long stroke and power, such as large size control valves, dampers, variable speed drives, through pneumatic cylinder (or springless diaphragm) operating mechanisms.

The positioner is a force balance type instrument, connected to the cylinder piston rod through a bracket and spring assembly. Every change in the controller signal produces a corresponding position change of the piston, and the positioner automatically returns to a null balanced condition.

The positioner is capable of han-

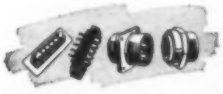
Meet the Hose Clamp Champ that LICKED Vibration

Aero-Seal's famous worm-drive principle set a new standard of hose clamp design—spread from aviation to automotive and wide industrial use. Vibration can't loosen Aero-Seal. And because clamping pressure is uniform all around there is no collapsing or distorting of hose or tube. Uses are legion in aircraft, automotive, marine and industrial products — wherever vibration is a problem and a tight connection the solution. But be sure to get the best — the *original* Breeze Aero-Seal Hose Clamp. Available in ALL STAINLESS STEEL or with STAINLESS BANDS with other components cadmium plated. Manufactured to conform to current ANA specifications.



Lightweight actuators for any requirement.

Flexible conduit and ignition assemblies.



Multiple contact connectors to meet government specifications.

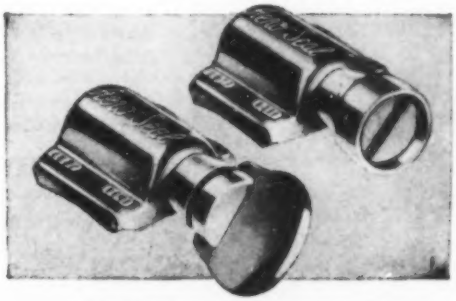
Job engineered, welded-diaphragm bellows.

WRITE TODAY for an Aero-Seal sample, outlining your intended use. Prove for yourself that Aero-Seal *is* the hose clamp champ!

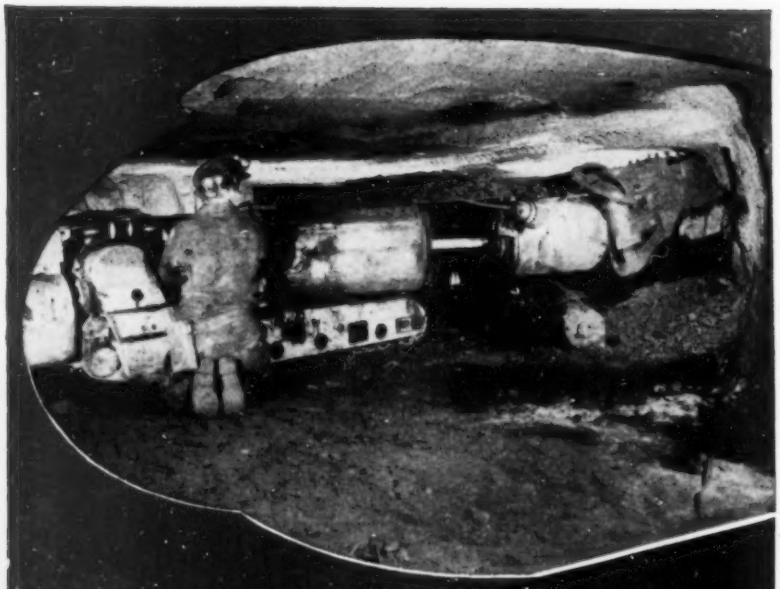
BREEZE

"Aero-Seal" HOSE CLAMPS

BREEZE CORPORATIONS, INC.
41 South Sixth Street Newark, New Jersey



AERO-SEAL Hose Clamps are available with screwdriver or thumb tab adjustment.



Mining 600 tons of coal a day with CONE-DRIVE® power

Joy Manufacturing Company's continuous mining machines can dig up to 600 tons of coal in two shifts and load it into shuttle cars.

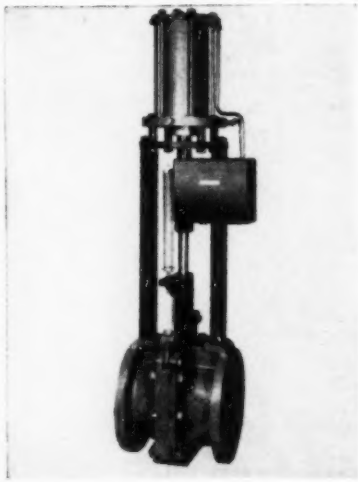
They are really rugged machines that require the ultimate in high capacity, compact, long life drives for the rotary drum cutter heads and conveyor mechanisms.

Five Cone-Drive worm gear sets per machine were specified by Joy engineers to meet these requirements.

The 65-hp. main drive for the cutter head has two 7-in. center distance, 5/1 gear sets. Three 3.577-in. C.D., 6/1 ratio gear sets drive the conveyors.

More and More mining equipment designers and users are turning to Cone-Drive standard gear sets and speed reducers for greater capacity and longer life in less space at lower cost.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan



dling up to 150 psig air supply, depending upon cylinder rating, and delivers, for example, 12 SCFM air flow with a 50 psig supply. It responds to a change in signal pressure of $\frac{1}{4}$ of one percent of range and positions a piston within one percent of its total stroke under normal loading conditions. Direction of piston movement with respect to a signal pressure may be reversed by inverting the positioner. Component parts are enclosed in a weatherproof case, measuring 6 in. x $7\frac{1}{4}$ in. x $3\frac{5}{8}$ inches. Air connections are $\frac{1}{4}$ in. NPT.

The illustrations shows the positioner unit with a cylinder operated crane pulp stock valve.

The Foxboro Co., Foxboro, Mass.

Varying Dimensions Represented in Digital Form

Called the Digitizer, a new electromechanical analog-digital converter can represent in digital form any varying dimension, function, or value, such as a distance between two points, a force, a temperature, or a voltage which can be resolved into a shaft position analog.

The digitizer is essentially a means of converting shaft rotational positions into electrical contact settings through which various readout, recording, or controlling devices can be actuated, making the device adaptable to automatic card and tape punching systems, and automatic tabulating equipment.

A feature of the unit is the provision for the separation of contacts from brushes during the rotation of the input shaft from one angular position to another. The effect of such a separation is said to give low torque-

to-drive, and almost complete elimination of contact and brush wear.

The standard production models can be operated normally at upwards of 18,000 rpm at the units decade, corresponding to 3000 digits per second. Torque required to start rotation of the units decade input shaft is approximately 0.005 inch-ounce. Standard production models are offered in three, four and five decade versions. Six decades and over can also be furnished.

The digitzer is miniaturized. The four decade model, for example, occupies an envelope measuring approximately 5 in. by 1⅛ in. thick, including contact-retracting solenoids. The weight of this unit is slightly over 2 pounds.

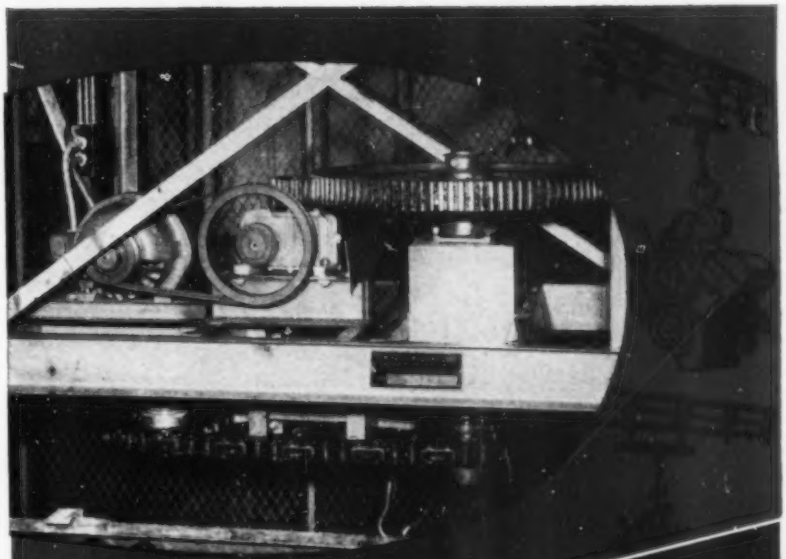
Coleman Engineering Co., 6040 W. Jefferson Blvd., Los Angeles, Cal.

Portable, Metal Hardness Tester

Permitting on-the-job metal hardness testing without damaging the material or part, a new portable, superficial hardness tester gives direct dial reading in Rockwell 15 N scale, 70-95. Its features for testing small parts and finished pieces are: low load; small indentation; and small diameter of penetration.

The tester eliminates the old baseplate or pressure-screw clamp attachment design, making possible the testing of any size, shape, and type of metal.

The tester has a spring-loaded diamond penetrator indentor, with the readings appearing on a 2 in. dia. scale. To take a hardness measurement, the handgrips are pressed downwards. This action lowers the indentor housing to bring the under surface of the tester against the surface of the material to be tested. After which, further depressing of the handgrips makes certain that the point of the indentor penetrates the surface of the test material under the action of the calibrated helical spring. The movement of the



Moving 85,000 lbs. on a conveyor with a 3" CONE-DRIVE

This 3-hp. drive unit, made by General Conveyors Corp., Van Dyke, Michigan, for a 1500-ft. long monorail conveyor, carries half the load of moving 170,000 pounds of V-8 automotive engines hour after hour, month in and month out. It's the kind of modern installation that demands continuous trouble-free operation.

That's why General Conveyors engineers specified standard 3-in. center distance, 15 to 1 ratio, Cone-Drive speed reducers for each of the two synchronized drives.

The ruggedness and maintenance-free long wear life of standard Cone-Drive reducers make them 'naturals' for conveyor drives. In addition, original units or replacement parts for these units can be delivered off-the-shelf for any emergencies.

CONE-DRIVE GEARS
Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

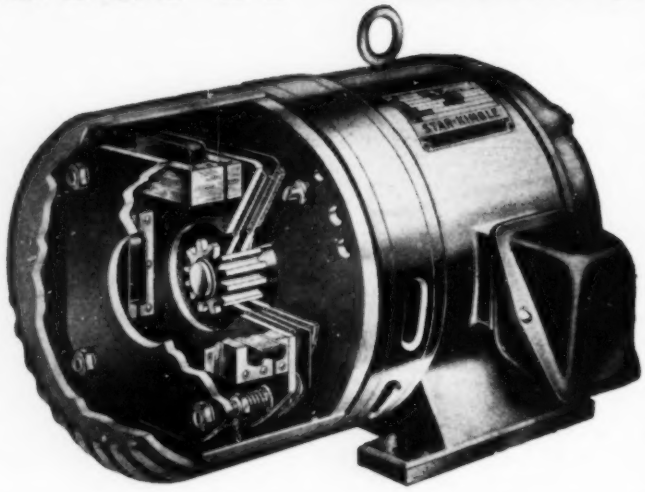
STOP! START STOP! START STOP! START STOP!

START STOP! START STOP! START STOP! START

START STOP! START STOP! START STOP! START

Instantaneous Drag-free

STOPS! STARTS



STOP! START STOP! START STOP! START STOP!

minute after minute YEAR AFTER YEAR
with Star-Kimble Brakemotors

That extra-large brakelining area you see brings a Star-Kimble Brakemotor and its connected load to an *extra-fast stop*—as short as a fifth of a second from full speed to standstill if desired.

And the small air gap contributes to *equally fast starts*. Brake is released the instant motor current is switched on—equipment starts without drag.

That's the story of a *single* Star-Kimble stop-start cycle. And the experience of user after user *proves* that Star-Kimble Brakemotors *maintain* the same split-second stops, the same smooth starts, through hundreds of thousands of cycles. In reversing service, conventional plugging methods with a typical 5 hp motor allow only 3 starts per minute. With a Star-Kimble Brakemotor, the figure is boosted to 10!

Of course, every Star-Kimble Brakemotor is a compact, integral unit designed to save space—and give rugged, dependable performance. One manufacturer—one responsibility.

For the full story, write for Bulletin B-501-A

STAR-KIMBLE
MOTOR DIVISION
KIMBLE PRINTING PRESS AND MFG. CO.
Bloomfield Avenue Bloomfield, New Jersey

indentor as it penetrates the material slightly compresses the diaphragm of a fluid-filled chamber. Fluid is forced further into the capillary tube, which encircles the dial, to indicate the hardness number of the dial scale.

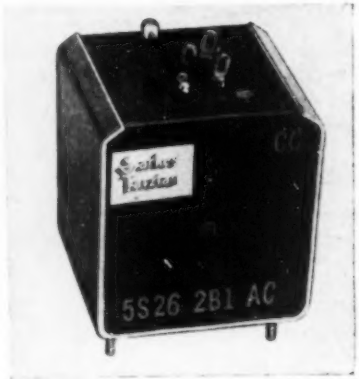
The movement of the indentor into the material is magnified about 3,000 times by the fluid displacement in the capillary tube. The final position of the fluid indicates the hardness value directly on the scale.

Weight: 30 oz.; Height: 3 in.; Maximum indentation: 0.003 in.; Maximum dia. of penetration: 0.006 inches.

Newage International, Inc., 235 E. 42nd St., N. Y. 17, N. Y.

Embedded Selenium Rectifiers

Embedded selenium rectifiers, available in many sizes, are designed for use in military equipments and will meet all specifications on environmental conditions, shock, acceleration and high altitude operation.



The typical unit illustrated will deliver the same d-c power as a hermetically sealed-can enclosed rectifier that weighs 1.8 pounds, and measures 7¾ x 4¼ x 4¼ inches. It will deliver 40 volts d-c at 1 amp under continuous operating conditions.

Sarkes Tarzian, Inc., Rectifier Div., 415 N. College Ave., Bloomington, Ind.

Fast Acting Electronic Controller

Said to be the fastest-acting ever designed, a new electronic controller has been developed that can actuate an electric brake in five one-thousandths of a second, said to be 80 percent faster than any control manufactured up to now. In addition to its increased operating speed, it can be controlled

at any distance from the brake either by a standard wire connection or by a transmitted wave, similar to a radio wave.

The control may be used in textile, aviation, packaging, machine tool, and on industrial applications where fast, emergency electric control is needed. It may also be used in atomic research programs where the radiation danger requires the operator to remain at a distance from the machines, and where the precision operation requires fast stops.

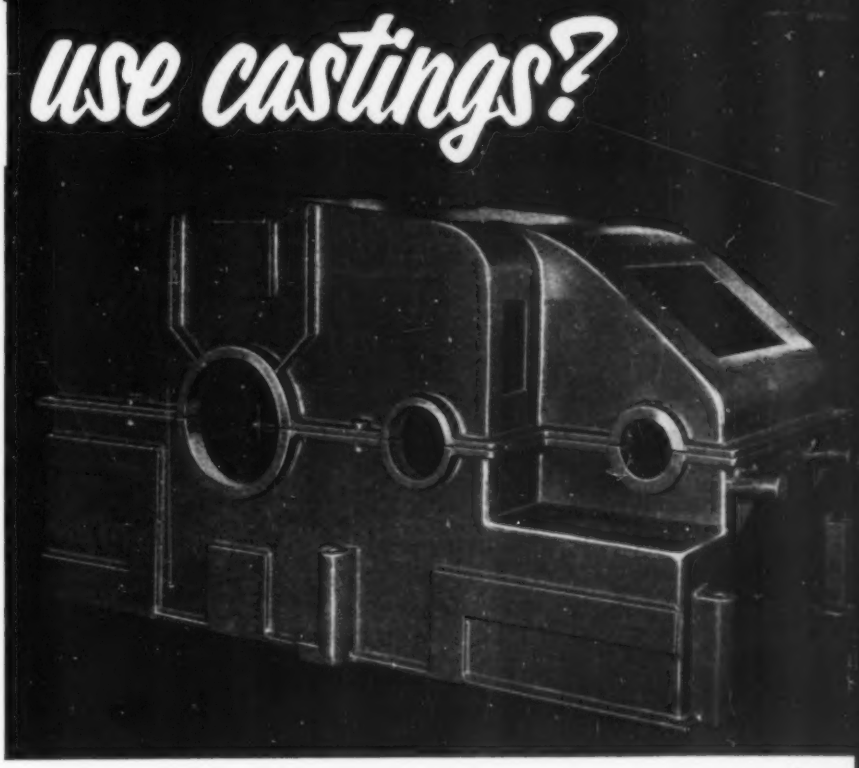
A safety feature of the controller is a twin stopping circuit. If one circuit fails, the other will actuate the control in two ten-thousandths of a second. Other safety features include a large condenser which stores electric power for emergency use, a sensitive limit switch, and electronic tubes charged with mercury vapor.

Warner Electric Brake & Clutch Co., Beloit, Wis.

High Speed Graphical Plotter For Strain Gages

Multi-strain gage data can be quickly and consecutively obtained in strain tests on aircraft and other large structures by means of a high speed graphic plotter like the unit shown in the illustration.

Through the elimination of reading, recording, and transposition errors, this unit gives a printed graphical record for easy reference. Dots and numerals are printed on a 12 in. chart by a strip-chart instrument at the rate of 48 points per 60 seconds. The chart paper is printed with 5x5 in. graphs staggered on 3 in. centers, plotting the percent load on the vertical axis



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CAN SAVE YOU MONEY!

Acme weldments are replacing castings for leading machinery and equipment manufacturers everywhere because they do a better job at lower cost. Experienced Acme engineers at work with Acme's complete fabrication facilities can give *you* these same advantages . . . Acme's new 24-page, illustrated booklet shows you why. *The Facts about Weldments and Castings* tells you what you should know about their relative strength, rigidity, vibration, design flexibility, and cost . . . facts to help you specify and save. And it's yours for the asking . .

—ACME—
TANK and WELDING
DIVISION of THE UNITED TOOL & DIE CO.
1089 New Britain Ave. • West Hartford 10, Conn.

- A.S.M.E. Qualified Welders • National Board Approved
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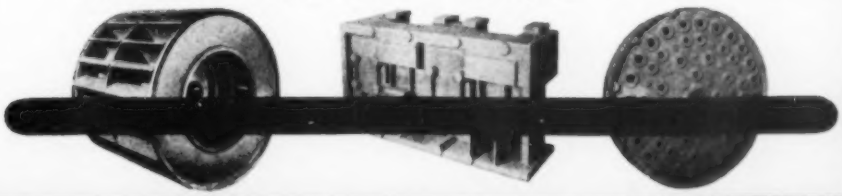
- Underwriters Label and Inspection Service • Navy Approved

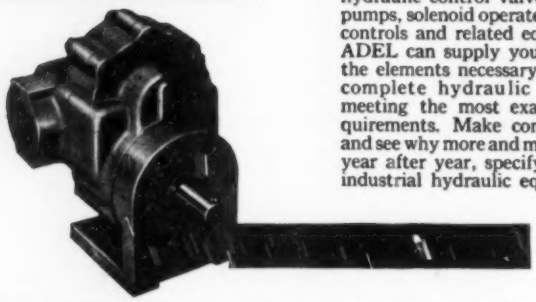
Write for yours TODAY!



ADEL

A COMPLETE LINE OF INDUSTRIAL HYDRAULIC EQUIPMENT FOR EVERY APPLICATION

For fourteen years ADEL has continuously directed its energies to the advanced development and production of high-quality hydraulic equipment. With the most modern facilities in our 150,000 square foot plant, we build ruggedness, efficiency and compactness into each ADEL unit. The variety of equipment being manufactured has been steadily expanded until today it encompasses a complete line of hydraulic control valves, power pumps, solenoid operated remote controls and related equipment. ADEL can supply you with all the elements necessary to build complete hydraulic systems meeting the most exacting requirements. Make comparisons and see why more and more users, year after year, specify ADEL industrial hydraulic equipment.



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CORPORATION,
10767 Van Owen St.,
Burbank, California

ADEL LEADER IN HYDRAULICS

DIVISION OF GENERAL
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Manufacturers of Industrial Hydraulic Valves and Pumps

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against the strain on the horizontal axis.

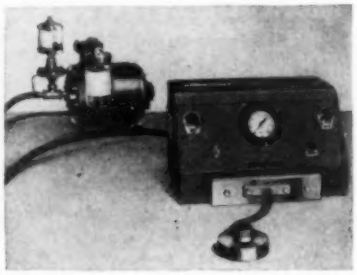
Zero control is possible by means of a 48 channel balancing circuit for use on two SR-4 strain gages with zero adjustment of 0.005 in. strain for each channel.

Strain scales of 2,000; 5,000; and 10,000 microinches for a 5 in. graph are available with a gage factor adjustment range of 1.8-2.2.

Gilmore Industries, Inc.,
5511 *Euclid Avenue, Cleveland* 3, *Ohio*

Compact, Portable Vacuum Tester

Testing such items as: shaft seals; diaphragms; cylinders; bellows; castings; small fuel tanks; pneumatic valves of all types; manifolds; plastics; and other parts, a new vacuum tester can also be used to reveal porosity or surface fissures, and to "prove" lapped surfaces, ground surfaces, or surface



flatness. The unit may also be used to test the effective sealing of complete assemblies and the efficiency of air cylinders.

Eliminating the water immersion test, the tester is easy to operate. The unit is compact and portable, comprising of a vacuum pump and an instrument panel with an attached testing plate. A single vacuum pump will operate several test panels.

Gits Bros. Mfg. Co.,
1866 *S. Kilbourn Avenue, Chicago, Ill.*

Electronic Scales For Trucks and Freight Cars

The platforms of new electronic type scales for weighing motor trucks and railroad cars are supported by four or six electronic weighing cells, depending upon the capacity. These cells are 6 in. high, are hermetically sealed, and contain permanent resistance wire strain gage units which transmit the weight impulse to the indicator. No other equipment is required in the scale pit. Track scales normally require

FOR REAL HELP TO SMALL BUSINESS

It is ironic that one of the first jobs of the Eisenhower administration, so widely, and erroneously, tagged as a "big business" administration, must be to go to the relief of small business. This is necessary because the preceding administration, while continually proclaiming its tender regard for small business, actually impaired gravely the ability of small business to carry on successfully. This it did in the necessary haste of devising an emergency tax program to finance rearmament and the Korean War. Now the new administration must revise this tax structure to give small business a chance to make its key contribution to an expanding American economy.

How Taxes Hurt Small Business

Since the outbreak of the Korean War, small business has been handicapped by two principal features of the emergency tax program:

1) Many small firms are unable to retain enough of their earnings to provide for expansion because these earnings are drastically limited by the excess profits tax.

2) Small companies have received a very small share of the tax concessions allowed by the federal government to encourage construction of defense facilities.

A small business that succeeds and hence grows is particularly hard hit by the excess profits tax. That tax, of course, applies to corporations having a net income of more than $25,000 per year. It results in taking up to 82 cents on every dollar of profit that the company earns above what is called an "excess profits credit." For most small companies the credit depends on what was earned in 1946-49. This creates an element of gamble and discrimination in determining the amount of tax to be paid. Time has proved that it is impossible to select a base period for the tax that is fair to all companies. A young company starting in 1946-49 is peculiarly vulnerable, as its earnings in that period were necessarily low. Even on modest earnings today it would pay a high excess profits tax.

It is true that Congress wrote into the excess profits tax law provisions to lessen the impact of the tax on growing companies. However, none of these provisions in practice has given much relief to small business.

"Relief" Provisions Give Little Relief

Small firms rely almost entirely on retained earnings to provide funds for improving their plants and equipment. They get very little help from the provisions (1) that no more than 70 per cent of total profits can be taxed away, (2) that additional earnings are allowed on an increase of invested capital or (3) that growing companies are allowed a

rate of return on capital equal to the industry average.

Most large firms can obtain additional funds in the securities market. But small firms find it difficult to increase their capital by selling securities, since investors generally prefer the stocks or bonds of nationally known and seasoned companies. Few small companies, therefore, can reduce their tax burdens by increasing their invested capital, and few can meet their needs for equity capital if their rates of profit are no higher than those of the leading companies which generally set the average profit.

Small business has been equally at a disadvantage in the matter of accelerated depreciation for tax purposes. The government has encouraged a great expansion of our industrial plant, despite the very high rate of taxation on corporate earnings, by granting certificates of accelerated amortization on new plants built to support the defense program. These certificates allow business to charge off the cost of defense plants at a rapid rate. This decreases the earnings that are subject to taxes, and so increases the part of the earnings that may be retained in the business.

Growth is Stifled

But most of these tax concessions have been made to large firms especially equipped to handle the complex problems of defense production. Of the $12 billion of new facilities so far approved for fast amortization, only 11 per cent are for companies with less than 500 employees, although the share of such companies in the normal civilian business is about 30 per cent. In only 2 of 12 industries studied by the Small Defense Plants Administration were small firms receiving what was estimated to be a fair share of the total tax amortization awarded.

Because they are unable either to retain enough earnings after taxes or to step up their depreciation allowances, most small firms are unable to keep up in the race to expand and modernize plant capacity. The Small Defense Plants Administrator, in his report to Congress, emphasized that small companies have been unable to do their full part in the defense program for lack of capital.

The Council of State Chambers of Commerce recently published an eight-state survey showing widespread cutbacks of plans for new plants by small and medium-sized companies. According to this report, "high federal taxes enacted since the beginning of the Korean War appear to be placing an effective brake on the rate of industrial expansion in all the states surveyed and probably in the 48 states generally . . . It is principally the small and medium-sized companies whose growth is being stifled."

Some Ways to Help

The first step to relieve small companies should be to free them from the excess profits tax. The nation as a whole would be far better off if the excess profits tax were allowed to die as scheduled on June 30, since the tax promotes waste as it stifles incentives. It is quite possible, however, that the politics of tax reduction, as opposed to the economics, will prevent the elimination of the tax during 1953.

If the tax is extended, provision should be made for a much broader exemption to smaller corporations. If net income up to $100,000 a year, which in these days still constitutes small business, were exempted from the tax, the loss of revenue to the government would be about $175 million. This relatively small amount could easily be offset by an increase in employment and incomes if small business is freed from its financial strait jacket and allowed to expand. Careful attention should be given also to the possibilities of allowing a higher rate of return on the first $1 million of capital (roughly the amount it takes to provide 100 jobs) and of making special accelerated depreciation allowances to smaller firms. This is a matter so important that we shall return to it in a future editorial.

Relief for small business—relief from a financial paralysis that has kept it from playing its dynamic part as a growth element in our economy—would do much to give the lie to the notion that the Eisenhower administration is a "big business" operation. Much more important, it would be a long stride toward releasing the dynamic energies of many small businesses and businessmen to forward a continuing and expanding prosperity.

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(1) PRECISION NON-FERROUS CASTINGS—Universal Castings Corp., Booklet 4000, 16 pp. Has illustrations of parts, and the chemical and physical properties of: brass alloy; aluminum bronze; manganese bronze; silicon bronze; nickel aluminum bronze; beryllium copper; and aluminum.

(2) ELECTRIC MOTORS—Doerr Electric Corp., Bulletin 100, 4 pp. Covers special application designs for pump, brake, power tool, hoist and fan motors, motor parts for built-in drives, and shows typical industrial uses.

(3) AIR POWER COMPONENTS—Mead Specialties Co., Catalog, 56 pp. With illustrations, it describes the complete line of single and double-acting air cylinders, and air operated presses, vises, chucks, valves, hammers, and work feeders.

(4) SMALL VEETICAL PUMPS—Allis-Chalmers Mfg. Co., Bulletin 52B6975A, 8 pp. Describes construction features of small vertical pumps for sidewall or submerged mounting. Units covered are available in capacities to 250 gpm. at heads to 125 ft. for coolant circulating, air conditioning, and other uses.

(5) BETTER GASKET SERVICE—Chicago Gasket Co., Bulletin, 8pp. Entitled "How to get Better Service From Your Gaskets," it answers questions on: swelling, shrinking, hardening, burning, leaking, use of compounds, and other ideas. Gives dimensions, weights, and properties of materials. Shows cross-sectional views of various types of facings and gaskets.

(6) ANALOG COMPUTER — Computer Corp. of America, Catalog, 12 pp. Complete with a full product description of the Integro-Differential Analyzer, the catalog discusses the general theory of analog computers, and describes the method of setting up problems for solution. Has several pages of typical examples in various fields of dynamics. Also describes the Function Simulator which makes possible the addition of backlash, dead-zone, and limit stops to computers.

(7) GEAR SPEED REDUCERS—D. O. James Gear Mfg. Co., Catalog 47-B, 84 pp. Has guide for determining character of load and service factors in selecting motorized reducers and gear speed reducers. Has sectional views, tables, or types of motors, drives, speeds, overhung loads, thrust loads, dimensions and weights, mounting positions, and rating tables.

(8) INDUSTRIAL PUMPS—The Deming Co., Catalog I-52, 96pp. Includes sectional and exterior views of the various types of units, together with selection tables and other data. Among the types discussed are standard models of centrifugal pumps including single and two ball bearing, side suction types, motor-mount types, portable types, self-priming centrifugal pumps, high pressure vertical centrifugal pumps, and split case centrifugal pumps.

(9) CORED FORGINGS—National Cored Forgings Co., Inc., Booklet 8 pp. Gives the Advantages and other data of brass, bronze, copper and other non-ferrous metals in the manufacture of cored forgings. Saves: metal; finishing time; machining time; reduces rejects; cuts tool cost; gives full strength. Has illustrations of typical products made. Tells what can and cannot be done in cored forgings.

(10) COLD TREATMENT—Bowser Technical Refrigeration, Bulletins, Descriptive, data on a line of units for the cold treatment of metals to —200 F or lower. Has specifications, construction data, and information on specific applications of cold treatment.

(11) D-C TO A-C CONVERTERS—Carter Motor Co. Catalog 452, 16 pp. Details on a line of converters with from 40 to 150 watt output. Models are available with 6, 12, 24, 28, 32, 64, 115, and 230 v input. Also has information on a line of inductor alternators. Includes specifications, performance curves, and other information.

(12) CAST OPTICS—Cast Optics Corp., Catalog, 8 pp. Has descriptions and tables of properties of four cast plastics, lists of features, brief fabrication instructions, and some accepted uses. Two are thermosetting allyl resins which can be hot formed, and one deep drawn. Another is a cast polystyrene with good optical qualities, and the fourth a cross-linked polystyrene developed specifically for UHF insulation.

(13) FLUID CIRCUIT DESIGN—The Logansport Machine Co., Inc., Manual, 32pp. Called "The Circuit Rider," it presents a simple discussion, together with drawings, of basic designs in fluid power circuits and points out the range of operations made possible through the application of different types of such circuits.

(14) LIQUIDS & GAS CONTROLS—Simplex Valve & Meter Co., Catalog 003, 32 pp. Lists many types of controllers, gages, manometers, valves, and venturi tubes for the measurement and control of liquids and gases for water and sewage works and power and process industries. Describes units, operating characteristics, construction details, mountings, specifications, and other data.

(15) AIR PRESSURE REGULATOR—Fischer & Porter Co., Catalog 29, 8 pp. Describes: the new constant pressure differential regulator, a unit used to regulate purge flows of liquid or gas, for liquid level measurement, or in dual arrangement for specific gravity measurement; and the instrument air pressure regulator. Has many illustrations, installation diagrams, and graphs.

(16) MICRO POSITIONER—Barber-Colman Co., Booklet F-3961-2, 6 pp. Has complete data on a light weight control element for automatic control circuits in aircraft. Basic applications include remote positioning, synchronization, temperature control, and detection and amplification circuits. Has illustrations and specifications of each model.

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(17) TEFLON PRODUCTS—Raybestos-Manhattan, Inc., Bulletin, 8 pp. Has description, service recommendations, and lists types of: gaskets; rings in irregular shapes; sheets; tubes; rods; tape; braided and plastic packings; packings for stuffing boxes and valve stems; and Vee-Flex packing rings. Also lists chemical, electrical, and mechanical properties of teflon, and suggested applications.

(18) FLAME PLATING—Linde Air Products Co., Booklet 8065, 12 pp. Describes the features of flame plating, lists the properties of the coatings, and the results of the wear tests of flame plated tungsten carbide coatings. Applications that have been tested are included, along with the limitation of the process. Also describes preparation and finishing of parts.

(19) COPPER AND BRASS PRODUCTS—Chase Brass & Copper Co., Bulletin. Lists almost 70 catalogs and technical handbooks on copper and brass products. Publications in the listing include descriptions of: copper and copper engineering alloys; copper bus conductors; copper wire, cable and magnet wire; copper water tube and fittings; brass and copper buildings products; copper tube and fittings for radiant heating; condenser and heat exchanger tubes; brass and copper industrial wire cloth; brass and copper rivets, burs and washers; and pipe and tube products.

(20) HYDRAULIC CYLINDERS—Lindberg Engineering Co., Bulletin 701, 28 pp. Diagrams, photos, and charts on a complete line of hydraulic cylinders explain the different mounting types and capacities of cylinders up to 1500 psi and 3000 psi working pressure. Has complete specifications for all models.

(21) SOCKET SCREW CALCULATOR—Standard Pressed Steel Co., gives all dimensions for a standard screw of a given diameter. Threads per in. The proper tap drill size in N.C. and N.F. series, and the body drill and counter-bore sizes are given for each diameter. Screw diameters on the calculator are nos.: 4, 5, 6, 8, 10, and ¼, 5/16, ⅜, 7/16, ½, ⅝, ¾, ⅞, and one inch.

(22) HYDRAULIC POWER UNITS—Vickers Inc., Bulletin 52-45, 4 pp. Describes the features and advantages of the custom-built hydraulic power units individually designed as to hydraulic system and cabinet to give convenience in installation.

(23) HOOK-ON INSTRUMENTS—General Electric Co., Bulletin GEC-901, 8 pp. Describes in detail a complete line of hook-on instruments, giving applications, operation, and the basic features of the hook-on type AK-1A volt ammeter; AK-2 watt meter; and the AK-3 power factor meter.

(24) GUIDE TO STEEL SELECTION—Joseph T. Ryerson & Son, Inc., Bulletin, 4 pp. Covers in condensed form the characteristics, mechanical properties and uses of a list of hot rolled and cold finished carbon and alloy steel bars, and is set up to make quick comparisons of the different types.

(25) RETAINING RINGS—Waldes Kohinoor, Inc., Catalog 50 M. 52 pp. Has engineering specifications, data, and other information covering 17 different types of rings and more than 600 different sizes. Gives ring and groove dimensions, clearance, allowable thrust loads, and safety rpm limits. Also applications covering self-locking ring types, basic ring types, rings for taking up end-play and rings applied radially.

(26) PRECISION CASTINGS—The Sessions Foundry Co. Booklet, 10 pp. Points covered are: tolerances; alloys used; minimum draft; machinability; dimensions; weights; surface detail; surfaces; smallest radii and holes; and thinnest edges. Has illustrations of parts for each point.

(27) PUMP, COMPRESSORS—Gardner-Denver Co., Bulletin QP-11, 40 pp. Presents standard types of air compressors, pumps, and rotary equipment (steam engines, steam pumps and power pumps). Illustrates all types and models, giving complete specifications for all units.

(28) CHAINS & STOCK SPROCKETS—Diamond Chain Co., Inc., Catalog 709, 54 pp. Gives points on how to select a stock roller chain drive. Gives speed ratios for combinations; installation and lubrication recommendations. Has many tables, hp ratings, illustrations and complete specifications for all types and sizes of chains and sprockets.

(29) NEEDLE BEARINGS—The Torrington Co., Catalog 32-B, 112 pp. Engineering and application data on various types of needle bearings. Has information on: calculations of needle roller applications; constants; load capacity; design factors; shafts; housings; precision fits; installation methods; lubrication; dimensions; and mountings. Covers all fields of applications, with illustrations, line drawings, and other data for each.

(30) SPINTESTING—Warren Bros. Mfg. Div. Bulletin, 4 pp. Information on spintesting equipment at speeds over 100,000 rpm. Used for testing: fan impellers; turbine rotors; compressor rotors; accessory turbines; and gyros. Gives illustrations and spinpit data, and the procedure on testing a turbine rotor.

(31) PILOT RELIEF VALVES—Fluid Controls, Inc., Catalog Sheets Nos. 1.11-1.15. One gives general data on the valves use, operation, design, construction and performance. Other sheets contain specific details on models available, detailed information such as pipe size, dimensions, weight, and performance characteristics. Also has cross-section views, engineering drawings, and piping layout.

(32) COMPOSITE METALS—Metals and Controls Corp. Catalog PR 700, 12 pp. Describes the various composite metals, precious metals, electrical contacts, and Truflex metals. Information on the platinum-group metals and manganese age-hardening alloys. Also has sections on thin gage rolling and mirror rolling. Completely illustrated.

(33) COLD DRAWN STEEL TUBING—Pacific Tube Co. Bulletin 10, 6 pp. Gives standard manufacturing tolerances on O.D., I.D., wall thickness, and commercial lengths for various sizes of tubing. Also, size ranges for cold drawn carbon steel and alloy steel tubing, stainless welded and drawn tubing, cold finished bars and precision shafting. Has average physical properties.

(34) CENTRIFUGAL PUMPS—Ingersoll-Rand. Booklet 7223, 16 pp. Data on general purpose centrifugal pumps on the cradle-mounted type. Covers 5 basic cradle groups and 17 corresponding pump types, their capacities, hp ratings and uses. Capacities: 5 to 2400 gpm. Pressures: 10 to 500 ft. total head. Specifications and illustrations of all models.

(35) HIGH TORQUE CLUTCHES—Formsprag Co. Bulletin, 6 pp. Describes the principle of sprag operation and how they are used in various types of clutches. Lists advantages, and applications of: over-running; indexing; and back-stopping clutches. Has cutaway views of the tree standard clutches.

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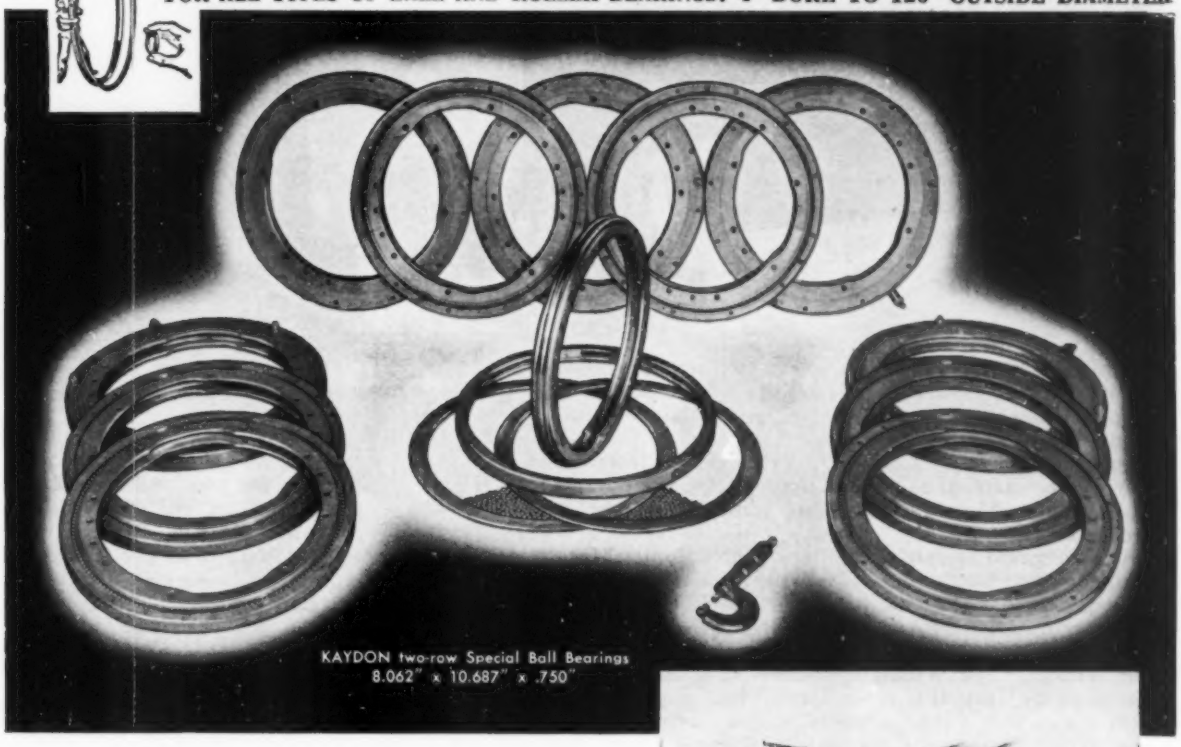

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As a safeguard against such failure, James Hunter Machine Company, the manufacturer, takes every precaution to insure the dependability of its transmission. The reel which carries the cloth in its Model A and Model S Dye Kettles is motor-driven through a Winsmith Type B, single reduction, worm gear reducer. "The Winsmith Reducer was selected for its dependability," say Hunter engineers. "Our experience with them is such that a change has never been warranted." Likewise, Winsmith reducers are used on Hunter Single Apron Dryers and Sample Dye Kettles.

The advantages of Winsmith Speed Reducers for any applications within the 1/100 to 85 hp range, in ratios from 1.1:1 to 50,000:1, have made them a distinct preference. Make sure *you* are acquainted with the complete, fully standardized Winsmith line of worm, helical and patented differential gear designs. Request Catalog 148.

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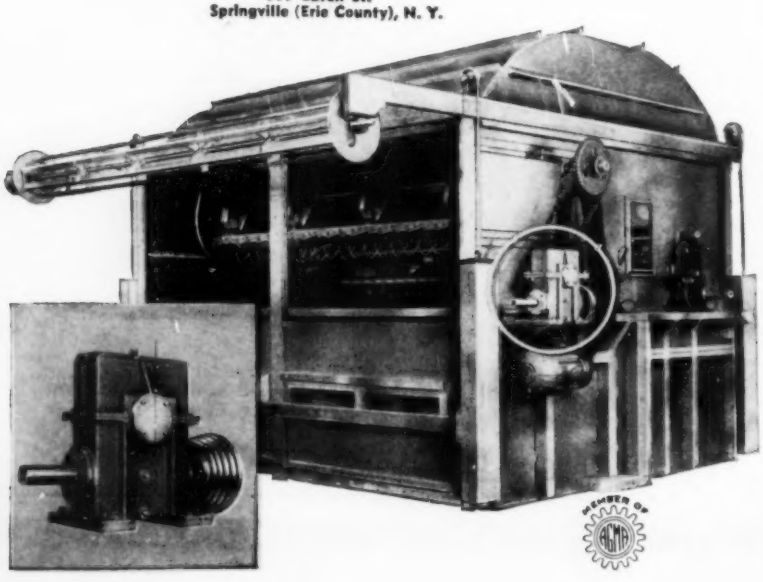

8 such weighing cells of a larger individual capacity.

Truck scale capacities range from 10 to 50 tons, and track scales go as high as 400 tons. Both visual and printed weights are offered in the MP-1 model shown. Weights in the 100,000 lb. range may be printed and read in 5 lb. increments. On the 200 ton track scale equipment, weights may be printed to the nearest 50 pounds. Electronic equipment is also available for fully automatic motion weighing of both trucks and freight cars.

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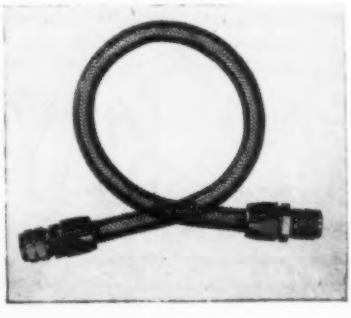

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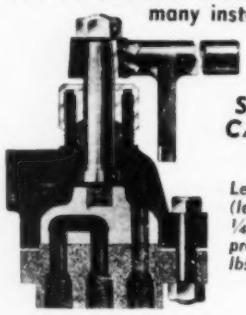

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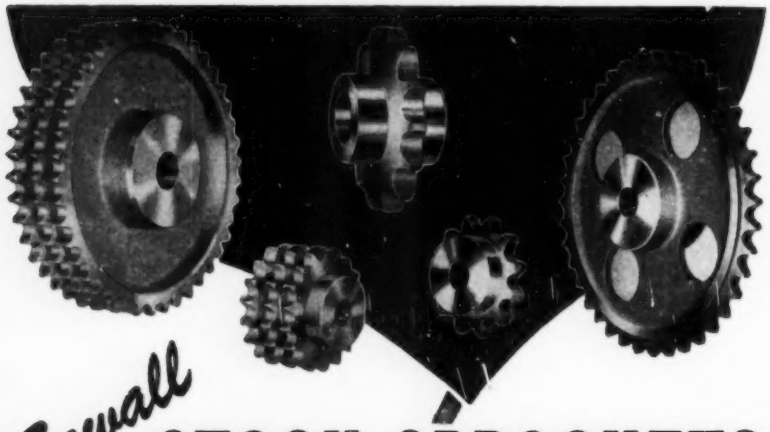

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are required for installation.

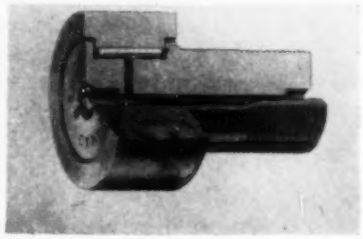
The braided tubing is stocked in two sizes, ¼ in. ID and ⅜ in. ID. It is available in six standard formulations and in running or fitted lengths. All fittings are stainless steel. The ¼ in. ID fittings can be field applied. The ⅜ in. ID crimped fittings are factory applied. Other sizes of tubing and fittings are available on special order.

This stainless steel braided tubing is recommended for use with almost any liquid, gas, or semi-solid, and is said to be effective in the handling of corrosive materials which must be protected from contamination. It can also be used in high pressure oil or compressed air lines.

U. S. Stoneware Co., Akron 9, Ohio

Heavy Duty Cam Follower Roller

Specially designed to meet heavy duty requirements, this type CTA cam follower roller has the advantage of a stud that is up to 100 percent greater in diameter, in relation to the size of the roller, than the stud found in any other cam follower. Because of integral flange on the stud, it is possible to increase the stud diameter to this extent. This offers the strength de-



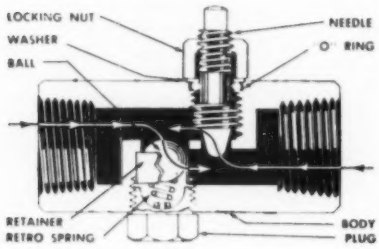
manded in special applications where high speed and heavy load carrying capacity are essential. The diameter of the stud can be specified larger or smaller to fit the need other than standard.

The stud is case hardened in the bearing section, but left soft on the threaded end to prevent snapping under impact or pressure. Threads are precision machined.

Smith Bearing Co., 17 Bear Tavern Rd., W. Trenton, N. J.

Flow Control Valve Has Flow In Both Directions

Equally efficient for air or hydraulic use, an improved flow control valve has full flow in one direction and a wide range of adjustments in the op-



posite, or controlled direction. The new valve uses a floating "retro-ball" check and an improved gland structure of the needle.

The gland structure combines the O-ring sealing principle with an adjustment locking feature. A light, helical spring does not "load" the ball, but locates it in the most sensitive floating position to the seat, regardless of the position in which the valve is mounted.

The manufacturer claims to have increased the valve's sensitivity, made possible higher operating pressures and improved operation of the new valve, permitting its use in many control applications.

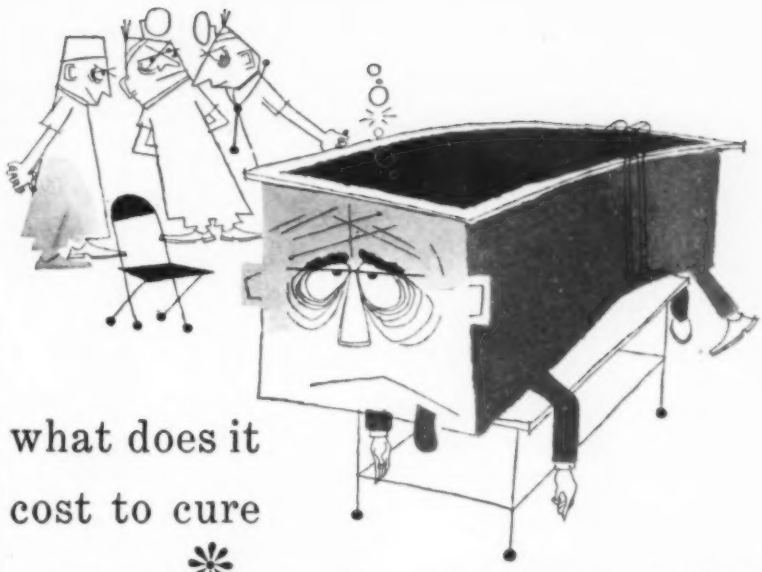
The flow control valves are made in 5 pipe sizes, $\frac{1}{8}$ in. to $\frac{3}{4}$ in., and are made from solid hexagon bars of brass, aluminum, steel and stainless steel. All other parts are stainless. Male end fitting tube adapters are available in the same material as valves. Operating pressure to 5000 psi.

Pneu-Trol Devices, Inc.,
1436 *Keating Ave., Chicago* 51, *Ill.*

Contains Components of Circuits

Designed to self-contain all the components necessary to a functional circuit so that the unit may be plugged into an electronic device, an assembly known as the Unistage is available in four sizes, so that any combination of from 1-tube to 4-tube circuits may be utilized.

Features are: (1) "Out-time" of a device is reduced, as a defective unit can be located and replaced; (2) the water-tight sealed container protects the components from changes in temperature, humidity, and from damage in handling; (3) in the development of new equipment, each circuit can be worked out independently and the self-contained circuit package can be produced before the final design is complete; (4) maximum efficiency and space conservation is possible with a product having complex circuitry; (5) the unit can be serviced at one source,



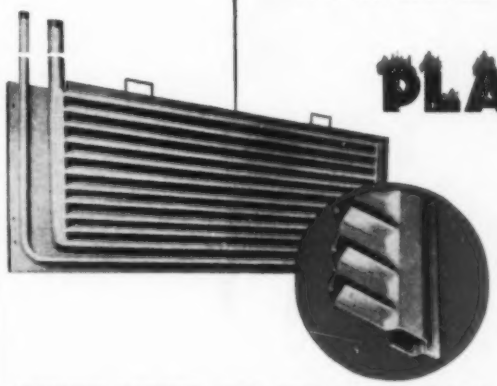
what does it
cost to cure
✻
coil-itis in your processing tank?

The constant care it takes to keep tanks operating when they're plagued with coil-itis is extremely costly. Downtime, and all the other maintenance time, slow heating and cooling ills of using old-fashioned pipe coils can be cured with Platecoils. As revolutionary as the new wonder drugs, Platecoils save as much as 50% in initial cost. They take 50% less space in the tank. They simplify maintenance and save hours of downtime. Compared to the hours it takes to clean and replace pipe coils, Platecoils can be cleaned and replaced in no time at all . . . without dumping the solution. It costs less to cure coil-itis with Platecoils than to suffer its evils. **Write for bulletin P77 today!**

PLATECOILS SAVE 50% IN HEAT TRANSFER COSTS

PLATECOILS COST LESS TO BUY, INSTALL, MAINTAIN

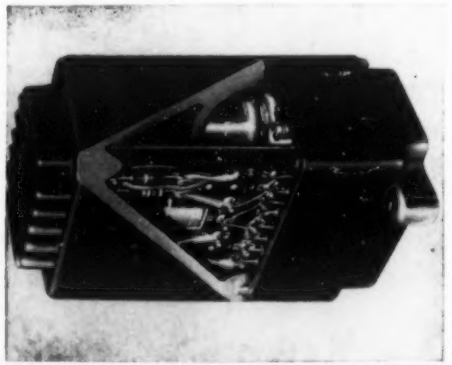
The Newcomb-Detroit Co., Grand Rapids Division, has found it is less costly to buy, install and maintain Platecoils than to fabricate pipe coils in their own plant. Ask about other case histories.



PLATECOIL
REPLACES PIPE COILS

✻
Coil-itis — Diagnosed as tank heating and cooling problems. Platecoils — the prescription for solving pipe coil problems.

PLATECOIL DIVISION, KOLD-HOLD MANUFACTURING CO., LANSING 4, MICHIGAN



eliminating the stocking of multiple parts.

The basic unit comprises essentially: the die cast aluminum housing; a terminal board having many single and through terminals coded for easy assembly of components; the tubeplate which allows the use of standard miniature sockets; and the tube well.

Technical Development Corp., 4070 Ince Blvd., Culver City, Calif.

Non-Slipping Screw Driver

Designed with a 11½ deg. lead to the recess of its cross slotted head, a new type screw can be driven in by the driver without any application of downward pressure. The harder the driver is turned, the tighter it grips the screw without kicking out. Although a special driver to fit the slot is suggested, an ordinary driver may be used with this screw. A torque test of up to 200 lb has been applied without slippage.

Weiloc Screw & Tool, Inc., 17 W. 32 St., New York, N. Y.

Fog Lubricator For Small Air Devices

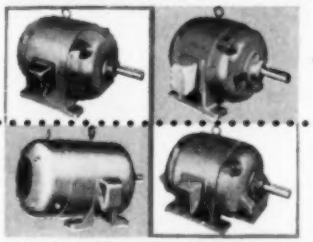
A new fog lubricator for bearings, spindles, gear boxes and small air powered devices is specially designed to produce a fine and uniform oil fog at low air flow. Called the Micro-Fog lubricator, its new features include: a constant oil level to give a uniform rate of oil feed; 360 deg. visibility of the oil flow; accurate metering of oil delivery into the air line to as little as 1 drop in 20 minutes by means of air control; and universal right to left or left to right flow without adjustment. In addition, it has other fea-

ELECTRO *Extra* DYNAMIC *dependable industrial motors*

1 TO 250 HORSEPOWER (N.E.M.A. STANDARDS)

One-piece cast iron frames.

Extra large "free-flo" air channels.



Permanently aligned cast iron brackets.

Liberal size grease lubricated bearings.

The WINDING is the HEART of the motor

1. *Extra insulation* in stator slots and between phases.
2. *Extra impregnations* and bakings of the wound stator.
3. *Extra high-frequency testing* of insulation between turns.
4. *Extra care* in fitting coils into stator.

QUALITY SINCE 1880

WRITE TODAY FOR NEW ILLUSTRATED CATALOGUE NO. 460

Also a complete line of Direct Current motors and generators

ELECTRO DYNAMIC
DIVISION OF GENERAL DYNAMICS CORPORATION
BAYONNE, NEW JERSEY

To get better prints... faster

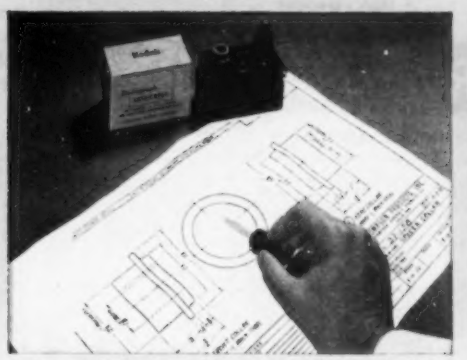
Tapco Plant, Thompson Products, Inc. uses Kodagraph Autopositive intermediates in print production.

The Tapco Plant knows full well that illegible shop prints pave the way for costly reading errors; knows, too, that Kodagraph Autopositive intermediates are low-cost insurance against such a possibility.

It therefore reproduces its more critical and complex jet and valve drawings on Kodagraph Autopositive Paper Translucent and thus obtains—quickly and easily—sparkling "masters" for print-making which have dense photographic black lines on an evenly translucent, premium-quality paper base; *which* will produce highly legible whiteprints time after time at *stepped-up* machine speeds.

Extremely fine-detailed drawings are reproduced on Kodagraph Autopositive Film, which captures the faintest detail . . . keeps close lines from "filling in". . . and produces top-quality photographic intermediates which have extremely fast print-back speeds.

No negative step . . . no darkroom handling. Kodagraph Autopositive Paper and Film are handled in exactly the same manner . . . produce positive photographic intermediates *directly*. First, they are exposed in one of the Tapco Plant's direct-process machines—or in a photocopy unit. Then, they receive standard photographic processing. A fast, convenient room-light operation all the way. And no new equipment needed.



Autopositive intermediates save creative drafting time. Tapco Plant makes necessary changes in its basic designs without costly redrafting by (1) making Autopositive prints of the original drawing; (2) removing the unwanted detail from the Autopositive reproduction with eradicator fluid. Then, the draftsman has only to add the new detail . . . and a print-making master is ready. *One* which will produce highly legible prints without confusing "ghost" images in the eradicated area.

Autopositive reclaims "unprintables." Many old drawings that have lost line density or are soiled or torn are transformed into print-making masters by reproducing them on Autopositive Paper or Film. Stains and crease marks are dropped out . . . weak detail is made more legible—saving hours of redrafting. Autopositive Paper is also used to duplicate a variety of office records, non-translucent vendor prints, etc.

Kodagraph Autopositive Materials

"THE BIG NEW PLUS" in engineering drawing reproduction

Write today for a free copy of "Modern Drawing and Document Reproduction." It gives complete details on the revolutionary line of Kodagraph Reproduction Materials, which you, or your local blueprinter, can process conveniently, economically.

MAIL COUPON FOR FREE BOOKLET

15

EASTMAN KODAK COMPANY
Industrial Photographic Division, Rochester 4, N.Y.

Gentlemen: Please send me a copy of your illustrated booklet giving the facts on Kodagraph Reproduction Materials.

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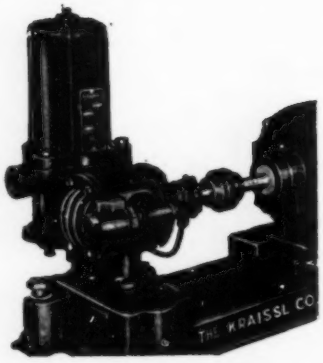
ROTARY AIR PUMPS

FOR VACUUM AND PRESSURE • AIR COOLED

Designed for high efficiency—for the *packaging and printing machine fields.* Rigorous on-job tests prove Kraissl pumps are the economy answer to your vacuum and air-under-pressure problems. Exclusive Kraissl design assures you maximum performance—and lower costs. Compact and lightweight—with exceptionally large capacities for size; force-feed lubrication system gives continuous heavy-duty service.

FREE!
Bulletin A-1289 gives you complete data on Kraissl Rotary Air Pumps. Write for it today.

If you have any special problems—if you need any detailed information—please write us fully. You will receive a prompt and detailed reply.



Features of Kraissl Class 25 Air Pumps

- Run at direct motor speeds—but not limited to motor operations
- Integrated oil-air filter available
- Forced-feed lubrication system
- Compact and lightweight
- High capacities

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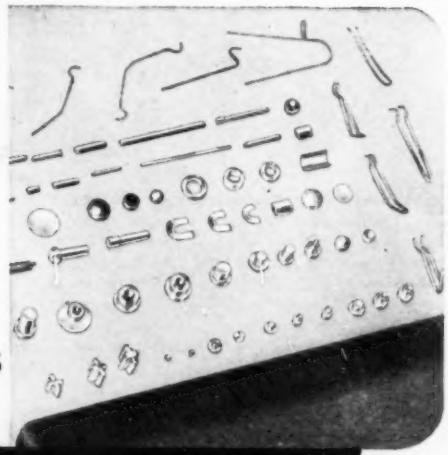
289 Williams Ave., Hackensack, N. J.

NEY

PRECIOUS METAL ALLOYS AND COMPLETE ASSEMBLIES



IMPROVE INSTRUMENT PERFORMANCE

Paliney*#7, Ney-Oro G, Ney-Oro #28, and Ney #90 Alloy are precious metal alloys developed in the laboratories of the J. M. Ney Company for the fabrication of contacts, brushes, wipers, slip rings, commutator segments, and similar components used in precision control and instrumentation. Each alloy has specific qualities which mean greater accuracy and prolonged instrument life, as well as resistance to most corrosive industrial atmospheres.

Parts fabricated from Ney's Precious Metal Alloys are now components of instruments used in navigation, recording, computing, and many other devices. Consult the Ney Engineering Department for assistance with your problems.

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tures such as: full view of the oil supply; cools as it lubricates high speed rotating parts; prevents entry of foreign particles into the bearing and spindle housing, or gear boxes; greater oil fog travel; uniform distribution of oil fog to multiple outlets.

It is used on ¼ in. air lines, and has rated air requirements from 0.8 cfm at 10 psi. to 6 cfm at 80 psi. Maximum safe operating pressure is 150 psi.; maximum safe temperature 120 F.

C. A. Norgreen Co., Englewood, Col.

Dynamometer For A-c and D-c Motors

Designed as a packaged unit for testing a-c and d-c motors, the model 52 custom dynamometer features a self-regulating absorption unit and a quick check torque scale that indicates directly in ft. pounds and horsepower. The self-regulating brake gives constant torque loading regardless of speed variations of the motor under test, making possible the simulation of conditions similar to those encountered

in actual operation of a motor. The quick-check scale permits unskilled personnel to make fast tests of motors without the use of computations or formulae.

Switch-gear is available for selecting either single or three phase power for the motor under test. Meters indicate a-c volts, a-c amperes, a-c watts and speed of the motor while it is in operation.

The cabinet has an adjustable work table for holding motors under tests. The unit is rated at 3 horsepower at 1800 rpm, and has a speed range up to 4,000 rpm.

George L. Nankervis Co., 19255 West Davison, Detroit 23, Mich.

MEETINGS

April 13-15

AMERICAN SOCIETY OF LUBRICATION ENGINEERS—Annual Meeting, Hotel Statler, Boston, Mass.

April 18-19

PACKAGING MACHINERY MANUFACTURERS INSTITUTE—Semi-Annual Meeting, Sheraton Hotel, Chicago, Ill.

April 20

SOCIETY OF AUTOMOTIVE ENGINEERS—Aeronautic Production Forum, Hotel Governor Clinton and Hotel McAlpin, New York, N. Y.

April 20-22

METAL POWDER ASSOCIATION—Annual Meeting and Show, Hotel Cleveland, Cleveland, Ohio.

April 20-23

AMERICAN MANAGEMENT ASSOCIATION—Annual Packaging Exposition, Navy Pier, Chicago, Ill.

April 21-23

SOCIETY OF AUTOMOTIVE ENGINEERS—National Aeronautic Meeting and Engineering Display, Hotel Statler, New York, N. Y.

April 27-28

AMERICAN ZINC INSTITUTE—Annual Meeting, Hotel Statler, St. Louis, Mo.

April 29-May 1

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND INSTITUTE OF RADIO ENGINEERS—Electronic Components Symposium, Shakespeare Club, Pasadena, Calif.

May 11-13

INSTITUTE OF RADIO ENGINEERS—National Conference on Airborne Electronics, Dayton Biltmore Hotel, Dayton, Ohio.

May 15-16

OPERATIONS RESEARCH SOCIETY OF AMERICA—Annual Meeting, Case Institute of Technology, Cleveland, Ohio.

May 18-22

MATERIAL HANDLING INSTITUTE—National Materials Handling Exposition, Convention Hall, Philadelphia, Pa.

May 21-23

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS—Spring Meeting, Hotel Schroeder, Milwaukee, Wis.

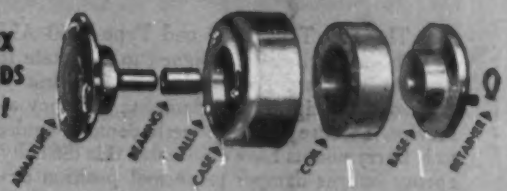
LEDEX ROTARY SOLENOIDS

...give positive, powerful snap action!

here's how a LEDEX ROTARY SOLENOID operates...

The magnetic pull moves the armature along the Solenoid axis. This action is efficiently converted into a rotary motion by means of ball bearings on inclined races. The inclined ball races are made to compensate for the magnetic pull increase as the Solenoid air gap closes, thereby providing substantially constant torque throughout the Solenoid stroke. The rotary snap-action power of the Ledex can be efficiently harnessed with a minimum of linkages, through the use of one or more standard features available on all models.

here's why LEDEX ROTARY SOLENOIDS are dependable!



As can be seen from the exploded view, Ledex Rotary Solenoids are simply constructed with few moving parts. All parts are manufactured to exacting tolerances and are carefully inspected and assembled.

The copper wire coil, the heart of the Solenoid, was developed especially for this product. It is wound by a precision winding process that puts a maximum amount of magnet wire into available space . . . giving tremendous power to compact Ledex Rotary Solenoids.

six basic LEDEX ROTARY SOLENOIDS to choose from!

Model Number	2	3	5	6	7	8
Diameter	1⅛"	1¾"	1⅞"	2¼"	2½"	3⅜"
Torque lb.-in.*	¼	1	5	10	25	50
Weight lbs.	⅓	¼	½	1	2¼	4¼

*45° stroke intermittent duty.

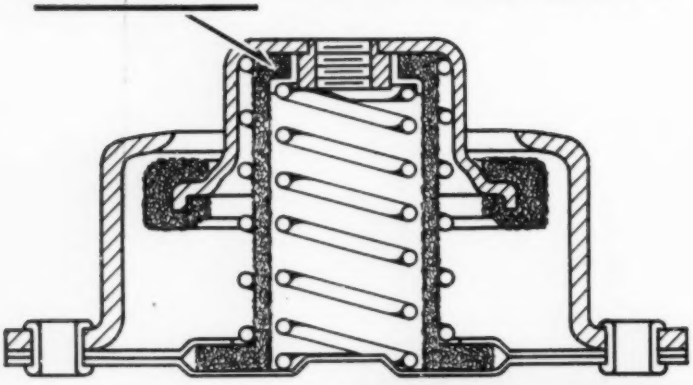
Engineering data is available upon request. Write for descriptive literature today!

G. H. Leland INC.

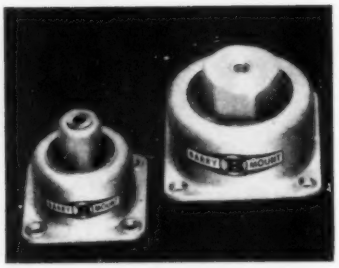
123 WEBSTER STREET, DAYTON 2, OHIO

SHOCK AND VIBRATION
NEWS

HERE'S THE SECRET



. . . of a NEW wire-mesh isolator that won't change on the job!



The new Type 7630 and Type 7640 ALL-METL Barrymounts have been specifically designed to eliminate loss of efficiency due to damper packing. Previous wire-mesh unit vibration isolators exhibited a definite loss of damping efficiency after a period in actual service, because the wire-mesh damper tended to pack. These new unit Barrymounts have eliminated this difficulty, because load-bearing spring returns damper to normal position on every cycle.

- Very light weight — helps you reduce the weight of mounted equipment.
- Hex top — simplifies your installation problems.
- High isolation efficiency — meets latest government specifications (JAN-C-172A, etc.) — gives your equipment maximum protection.
- Ruggedized — to meet the shock-test requirements of military specifications.
- Operates over a wide range of temperatures — ideal for guided-missile or jet installations.

Compare these unit isolators with any others — by making your own tests, or on the basis of full details contained in Barry Product Bulletin 531. Your free copy will be mailed on request.

Free samples for your prototypes are available through your nearest Barry representative.

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Atlanta Baltimore Chicago Cleveland Dallas Dayton Detroit Los Angeles Minneapolis New York
Philadelphia Phoenix Rochester St. Louis San Francisco Seattle Toronto Washington

Memory Devices

The current state of memory device design and development is changing so rapidly that most up-to-date information is contained in periodicals. The following is a list of selected references from recent periodicals. The fundamental principles of some of these devices are covered in the article "Making Machines Remember" on page 141 of this issue.

1. Digital Information Storage in Three Dimensions Using Magnetic Cores. J. Forrester, J. App. Phy. V22 N 1 Jan. '51, P. 44-48.

2. Electrostatically Induced Permanent Memory. C. F. Pulvari, J. App. Phy. V. 22 N 8 Aug. '51 p. 1039-1044.

3. Information Theory and Most Efficient Codings For Communications or Memory Devices. L. Brillown, J. App. Phy. V 22 N 9 Sept. '51 p. 1108-1111.

4. Standards, Institute of Radio Engineers, Proceedings V 39 N. 3 Mar. '51.

5. Designing Office Size Electronic Analogue Computers. *Electrical Manufacturing*, p. 47 n4 Apr. '51.

6. Dynamically Regenerated Electrostatic Memory Systems. J. P. Eckart, H. Lukoff and G. Smolar. Inst. of Radio Eng. Proc. V 38 N. 5 May '50, p. 498.

7. High Speed Digital Computers. L. N. Redenour, J. App. Phy. V. 21 N. 4 Apr. '50 p. 263-270.

8. SEAC. *Electronics*, V. 23, N. 9 Se. '50 p. 120-122.

9. *Nature*. V. 164 N. 4173 Oct. '22 '49 p. 684-7.

10. Improved Ultrasonic Delay Lines, F. A. Mets, W. A. Anderson, *Electronics*, V. 22 July '49 p. 96-100.

11. Mercury Delay Line Memory Using Pulse Rate of Several Megacycles. I. C. Auerback, J. P. Eckart, R. F. Shaw, C. B. Sheppard, Inst. of Radio Eng. Pro. V. 37, N. 8 Aug. '49 p. 855.

12. *Electronic Engineer*, V. 20 N. 245 July '48 p. 208.

13. Ray Tracing, M. Hertzberger, Opt. Soc. Am. J. N. 7 51 p. 805.

14. Ferroresonant Flip-Flop, C. Osborn, *Electronics* V. 25 Ap. '52 N. 3 p. 121.

15. *Engineer*, Vol. 192 N. 7, '51, p. 738-9.

16. Ferranti, Manchester Electronic Computer.

Another Digital Computer

"OARAC"—Office of Air Research Automatic Computer—developed by General Electric Co. for use at Air Force's Wright Air Development Center solves complex problems involving aircraft design, guided missiles and ballistics.

Brain of the computer is a metallic drum which holds pulses representing ten-thousand ten-decimal numbers on its magnetized surface. The memory cylinder also holds instructions telling what to do with the numbers when they are called into play. Both the

numbers and instructions can be wiped off or left on the drum as long as desired. Information is fed into the machine by typewriter on an input unit which puts the information on magnetic tape, from which it is transferred to the memory drum. Answers coming out of the computer are received on magnetic tape and printed on an automatic typewriter.

One of the most significant features of the new computer is its ease of maintenance. About 1,400 electronic tubes, relatively small number for a machine of this type, and nearly 7,000 germanium diodes are used. The tubes are incorporated in a series of plug-in "turrets," each of which is a complete circuit in itself, designed to perform a complete function. Seven different types of turrets are used, each representing a different type of operation. In case of failure, it is only necessary to replace the faulty turret to set the machine in operation again.

Another feature is the push-button panel which is used for regular checks on the operation of the computer. The panel can also be used for the solution of relatively simple problems. Operation is to push a series of buttons representing the various numbers involved, and then push another button which tells the computer either to add, subtract, multiply, or divide. The answer is indicated in a fraction of a second on a series of lights at the top of the panel.

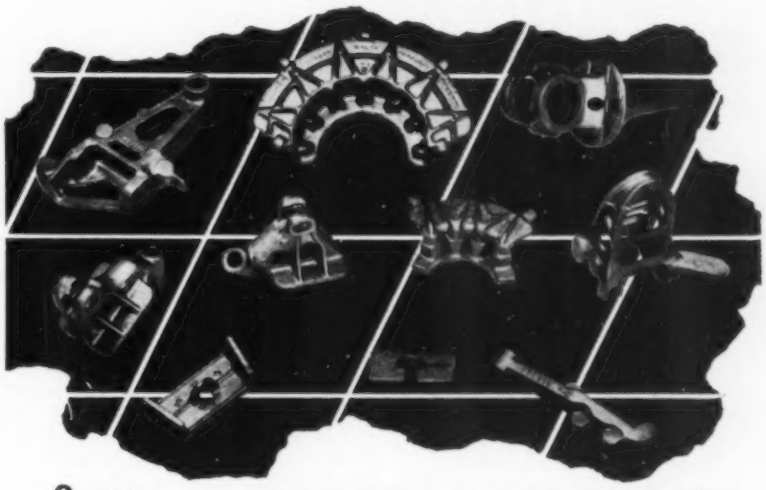
An important use of the OARAC will be in solving repetitive problems. The computer holds the constant numbers on the memory drum, takes the slight variations into account, and calculates the answers in a few hours.

HARD-FACING ALLOY yields successful results when applied to large guide rolls, hot friction guides, soaking tong bits and lips of copper converters, according to Coast Metals, Inc., Little Ferry, N. J. CM-119 can be applied with any good arc welding process. It has simple welding characteristics for efficient bonding, and can weld over itself and other ferrous materials without cracking, checking or parasity.

TYPE X-5, recently developed Furane Plastics Co. resin coating, resists corrosive action of acids and alkalis, solvents and boiling aqueous solution. Applied from solution to a film thickness of ½ to 1 mil, and baked for an hour at 330 F or several minutes at 500 F, the cured black film shows positive adhesion to many clean metal surfaces. Use of the coating as a primer makes difficult to-adhere-to surfaces more receptive to adhesive.

WARPAGE? SHIFTS? DISTORTION?

... Are These Tolerance Problems Causing You Unnecessary Machining Costs?



Call in UNITCAST!

Unitcast doesn't sit back and rest on customer praise or previous accomplishment. Mass production of Unitcastings continues to grow by leaps and bounds as *promised accuracy* continues to be an important part of each and every unit. Unitcast offers no "stock answers" for your problem. With 30 years practical "know-how" experience backed by a complete foundry engineering staff, each job is given individual attention. It only costs a three cent stamp to have Unitcast go to work on your own "tolerance headache" so why put off writing any longer?

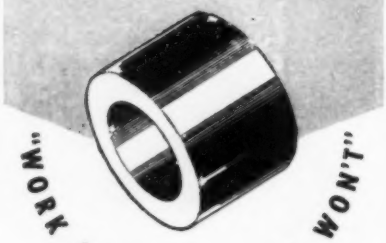
UNITCAST Corporation
QUALITY STEEL CASTINGS

Give us a chance to offer a "cast steel" answer for your parts problem. Our suggestions while your product is in the design stage will pay continuous dividends.
Write or call today. Unitcast Corporation, Steel Casting Division, Toledo 9, Ohio; 701 New Center Bldg., Detroit, Michigan. In Canada, Canadian Unitcast Steel, Ltd., Sherbrooke, Quebec.

UNITCASTINGS ARE FOUNDRY ENGINEERED

GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.

OIL-FREE
SELF-LUBRICATING
BUSHINGS



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Ad Libbing by the Editor

Rats and Ships

One night on my way home I happened to meet Big Frank unexpectedly. He looked glum and obviously was boiling inside. His face looked like a thundercloud. His first words were, "Have dinner with me." So we had dinner together.

All during the meal, as was his custom, Big Frank talked of everything and anything except what was on his mind. He always made it a point to keep the conversation on a cheerful note during the meal.

As we were drinking coffee, Big Frank opened up. He glared at me and grumbled, "Now Charlie wants me to give him some stock for nothing. He says he should be entitled to it because he used his influence in getting the machine tried out on his railroad. He's crazy."

I nearly jumped out of my skin when I heard this. Charlie had always bucked Big Frank at every phase of the operation. When Big Frank tried out the machine on its trial run, Charlie jibed and criticized because of the machine's low capacity. And at every opportunity, Charlie rudely derided Big Frank's venture, claimed it was doomed for failure, said he thought the railroad was crazy to let Big Frank try the machine and in every possible way, Charlie condemned the whole venture.

Now two years later Frank and his machine were riding high and mighty. The whole railroad industry began talking about it. It was a huge success. Charley certainly had a crust when he demanded that Big Frank give him without cost shares of stock in the business. I said something to that effect and Big Frank just guffawed and said:

"You know George, rats desert the sinking ship and they stay off the ship as long as that ship is sinking. What is more, if it is a wooden ship the rats probably gnawed the holes into the ship and that is what made it sink. So they all run off and swim away. But as soon as everything on the ship is fixed and the ship is not sinking any more and she is going to sail off on a prosperous journey, all the rats come back on the ship and eat the grain or whatever it is that the ship carries.

"That is the way it is in business

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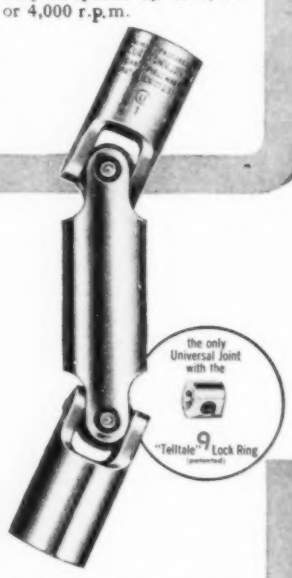

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too. If it looks like your business is not making money the rats, they start to disown you. They are the ones who tell everybody that you are no good, that you cannot pay your bills and that your business is going to go bankrupt. But then there are others too, who are really friends and they are not rats. When you are in trouble they have faith in you. When they see you doing something wrong they tell you. If they think it is right they tell you. And they also tell everybody else that they think you are going to win and that you will have a good business some day. They are truthful when they say it because they have given you a chance to tell everything and why you think it is going to work.

"So it is that sooner or later if you are a good business man and your idea is sound your ship of business becomes a success and makes money. And it is then, George, that all the rats come back to the ship which is now no longer sinking but is sailing high and mighty.

"And that is the way it is with Charlie. He had no use for me or my business when he thought it wasn't going to pay and that I was going bankrupt. But now he shouts loud what a wonderful business I have and then he comes to me and asks me to give him some of it for nothing.

"Just remember this, George, there are more men who know how to run a business that is successful and that keeps on being successful than there are men who know how to run a business that is in the red or is going in that direction. Everybody seems to think they can run a successful business but there are very few men who will have anything to do with a business that is headed for bankruptcy."

There is much truth in every word that Big Frank spoke. There is always a hoard of men ready to climb on the bandwagon when everything looks rosy. I am reminded of Rudyard Kipling's famous lines, where he quotes a British regular army soldier, speaking in peacetime:

> "It is Tommy this and it is Tommy that and it is Tommy all around,
>
> But it is 'how do you do Mr. Atkins,' when the band begins to play."

Let's Just Admit It

One of the things that repeatedly riles me terrifically is to hear a lot of engineers talking about the status of engineering as a profession. They seem to be bemoaning everything there is about engineering. They accuse "the profession" of being inarticulate,

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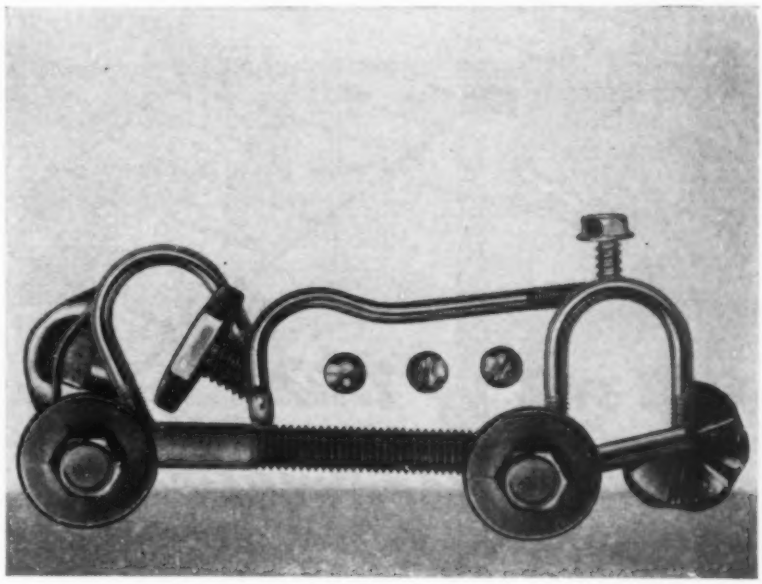

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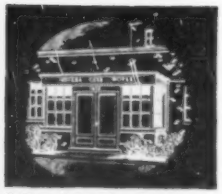

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cringing, unassertive, and therefore relegate it to a low position in the social and business structure. Those fellows just love to weep on each other's shoulders and complain bitterly over their imaginary ills.

It is not surprising to me that lay people outside of the engineering profession have little or no idea of the importance of engineering and the great positions occupied by engineers. Sarcastically speaking, perhaps the world would never have known that Herbert Hoover was an engineer if he had not been blamed, and unjustly so, for the depression.

Let us look at the score. Almost one hundred percent of all the steel produced in the United States is produced by companies headed by men who are engineering graduates, including such men as Clifford Hood of the United States Steel Corporation, Eugene Grace of Bethlehem, Tom Girdler of Republic and many others. The managers of practically all of the steel companies in the United States are engineering graduates.

When we consider communications there is Cleo Craig an electrical engineering graduate of the University of Wisconsin and president of the greatest corporation in the world, The American Telephone and Telegraph Company. And there is also engineer David Sarnoff of the great Radio Corporation of America. When we talk about the chemical industry, we have Crawford Greenewalt, president of duPont and also the top executives of Dow Chemical Company, all of them chemical engineering graduates.

We can take industry by industry in the same way and in each instance, we will find that the industry is dominated by engineering talent. And when it comes to the greatest activity in the world today, namely the defense program of the United States of America, we find it headed by Charles E. Wilson, mechanical engineering graduate of Carnegie Tech.

Add it all up and what do we have? We have to face the stark reality that if the engineering talent of the United States were wiped out tomorrow this whole country would quickly descend into a position as a "tenth" rate nation. Engineers do not have to prove to themselves and others that engineering is a great profession. All they need do is simply admit that this whole material civilization hinges entirely upon the engineering profession. Without that profession there would be no material civilization as we know it today. So let's throw away the hammer and beat the drum and toot the horn. Engineering is a great profession.

—G. F. N.

What Makes A Successful Design Engineer?

GEORGE H. LOGAN
Starr Engineering Company
North Hollywood, California

ENGINEERING DESIGN is creative work, the evolution by thought of things new and useful. No less than the artist or musician, the designer has to have the inner spark that urges him to produce entities out of void. His eye penetrates the opaque, his mind builds three-dimensional mechanisms of functional nature, he has an inate talent for *imagineering*. The spark need not be large; if it exists at all, it can be made to grow into a catalytic agent to the man's success in product engineering, to building the inner satisfaction linked with achievement.

For those who must invent and design mechanical devices, as other men to be content must paint or write music, how best is the spark nurtured? One highly important step in the development of creative capabilities is to think of the brain as a rubber band, compel the intellect to stretch in many directions when attacking a design problem. A good way to do this is to write down the hard-core parameters of the assignment and then think radially outward from the core, surrounding the hub with spokes of ideas for solution. Such cultivation of uninhibited thinking is a highly effective strategy in out-maneuvering design difficulties. The designer should urge his thoughts toward unorthodox approaches to the problem. Some of the attacks may well be impractical at the outset, but ideas beget ideas. Yet out of such thinking, may come ingenious solutions of the kind that prompt people to say: "Why didn't I think of that myself!"

The sensation of dull labor is experienced at times when but one inadequate approach to a problem has been conceived, and it is a bitter struggle trying to make it alone provide a total answer. However, there is relief from such frustration once the "mind of rubber" concept is adopted and used. With it, the facility of design execution and the degree of inspired novelty are tremendously increased and the time for finishing the job reduced.

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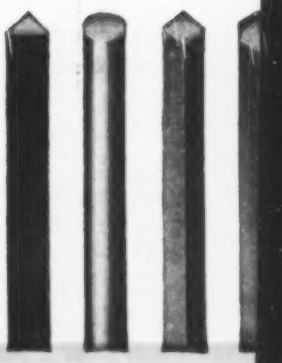

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unfettered thinking, not bound by precedent or the obvious, cannot fail to develop singular versatility and sureness of performance. And once that control of the mind is completely held by a design engineer, he has taken a large step toward more recognition.

The belief in and practice of work organization should be closely associated with the acute-mind principle just described. To gain full advantage of a volatile imagination, the products of that imagination should be recorded in a manner easy to analyze. Explicitly, when the designer receives an assignment, he should start a notebook labelled "Original Data, Project ————". The first sheet might carry the captions "Project Objective" and "Project Background". The definition under "Project Objective" can be based on discussions with the individual or individuals initiating the assignment. With this concise statement of what the project must accomplish, the engineer possesses a valuable springboard for his work. Lacking such definition, much time can be wasted through imperfect understanding of what the project is supposed to produce.

The data listed under the heading "Project Background" is, in general, anything that contributes to the expeditious handling of the problem. It can be a compilation of patents showing prior art in the field or a synopsis of sales department ideas on features that will give a product maximum marketability. This background material might also include any literature that describes competitive products. Such information is a valuable guide to setting design goals as they pertain to product cost, performance and customer acceptance.

Once these basic facts are recorded, the engineer starts adding sheets describing his own work to the Data Book. These trace the progress of his thinking. The earliest of the pages are generally mere freehand sketches and notations on first ideas. But the very act of placing these visualizations on paper often suggests simplifications or combinations of preliminary ideas that later become the basis of the final product. Appropriate calculations are, of course, inserted as they occur.

Another step in cultivating imagineering is to make a habit of closely scanning both the editorial and advertising pages of industrial magazines and society journals. Each page has something to contribute to a designer's fund of knowledge. And, in many cases, design descriptions suggest the solution to an immediate problem.

Through the ages artists have borne the implication, whether justified or not, of being temperamental. The engi-

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neer cannot afford to be the target of such comment. He should discipline his mind, control his speech and actions so that he achieves full emotional balance. Regardless of how much brilliance he develops, how much information he has absorbed, unless he controls his reactions to disturbing stimuli, he builds a barrier to advancement. Emotional balance is an intangible will-o-the-wisp, often more difficult to secure than technical skill itself, yet it is, at least, of equal importance.

Building a calm temperment is not always easy, but it can be done if *restraint* is practiced. Speech should be restrained when matters turn sharply controversial. At such times, it is wise to interject a cooling off period before again trying to sell a sincere idea. Likewise, there is little value or reward for worrying about things over which one has absolutely no control. The emotionally balanced engineer never permits the factual approach to be warped by irritations, for it is the serene and objective mind that belongs to a man who can perform.

In consideration of an engineer's legitimate ambition to progress, the importance of broadening the knowledge of non-technical business topics should not be overlooked. It is largely true that this is an age of specialization, and that each individual must master his specialty. Therefore, it is the alert design engineer who channels into his available time the study of industrial subjects other than engineering. Consider men in management positions. Almost invariably they have stored information that equips them to make decisions on matters such as economics, accounting, law or industrial relations. And the greater the responsibility, the broader the scope of knowledge needed to understand and evaluate the endless variety of subjects that thread industry. Therefore, it is also desirable to soak up information appearing in journals like the *Harvard Business Review*, which treats topics such as "Utilization of Older Manpower;" "Basic Elements of a Free, Dynamic Society;" and "An Economics for Administrators."

"Rubber band" thinking is required of an executive. His mind must blanket and swarm all over problems, exploring every pertinent facet. He must be able to make quick decisions that are correct most of the time. He is always ready to switch from objective thinking to abstract thinking for it is by the latter thought process that sweeping, inspired plans are made. Thus, through rigorous discipline and actions ordered by a disciplined mind, the creative design engineer can make for himself an opportunity that leads to an outstanding position in his chosen field.

ENGINEERING ABSTRACTS

Die-Casting Design For Easy Ejection

Abstracted from "Expansion of Die-Castings in the Cavity" by L. C. Barton, *Mechanical World and Engineering Record* (London), November 1952.

AN INVESTIGATION REVEALS that non-ejection of die-castings containing inserts results from neglecting to consider the ratio of the cross-sectional areas of the insert and the cast metal.

A common difficulty in the production of die-castings is the ejection of some poorly designed small insert-carrying die-castings from multi-cavity dies. A component such as the zinc-alloy knob with a laid-in threaded shank shown in Fig. 1 is an example. While the die is cold, the casting can be ejected satisfactorily. But as normal

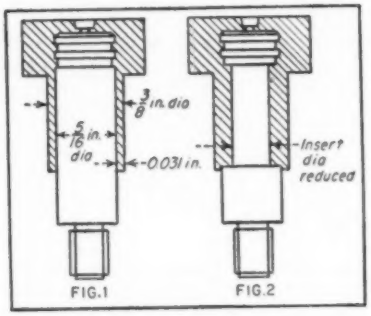

FIG. 1—Large thermal expansion of insert and a relatively thin die-cast wall prevent ejection of casting until insert cools.

FIG. 2—Diameter of insert reduced to decrease its thermal expansion facilitates ejection of die-casting.

working temperature is approached, ejection becomes more and more difficult.

Although the difficulty of ejection may be accentuated by poor die design such that runner shrinkage tends to draw the castings tightly against the wall of the cavity, the fault lies in the design of the casting rather than in the die.

When castings like that of Fig. 1 are being produced, the injected metal completely fills the annular space between the hot cavity wall and the relatively cool insert. The influx of hot metal causes the insert to expand be-

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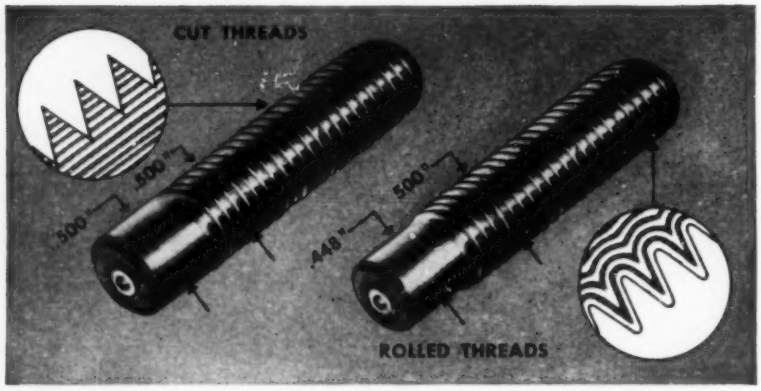

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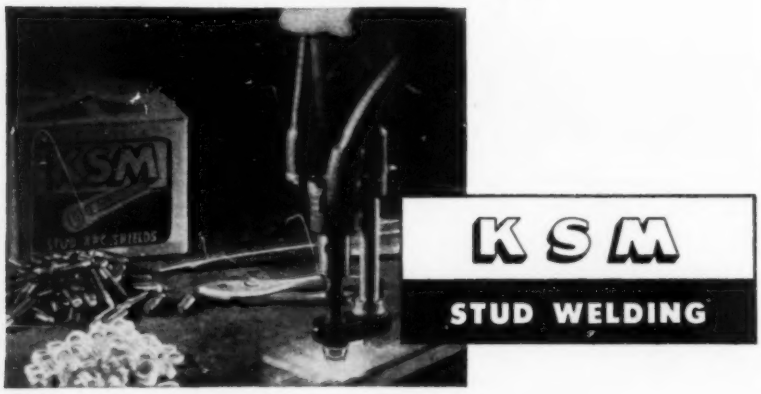

fore the zinc-alloy sheath around the insert can contract. In expanding, the casting comes into closer contact with the cavity wall instead of shrinking away from it.

It is this expansion that makes ejection difficult. The die-cast sheath cannot contract until the steel insert cools. Even then shrinkage is less than normal.

With inserts turned down in diameter as shown in Fig. 2, it was practicable to eject the castings with no great effort immediately after die-casting.

Based on experience over a wide range of sizes and ratios of cross-sectional areas, the dimensions given in the accompanying table are considered desirable to obtain easy ejection.

Safe Insert Diameters For Given Diameters of Die-Castings

Outside dia of die-casting, in.	Max dia of insert, in.	Wall Thickness, in.
1/8	0.088	0.018
1/4	0.175	0.037
3/8	0.265	0.055
1/2	0.353	0.074
5/8	0.445	0.090
3/4	0.532	0.109
7/8	0.620	0.127
1	0.710	0.145

Cavity draft, within the usual limits, has little effect on the initial thrust necessary to eject the casting. Deep circular recesses in the cavity are difficult to polish longitudinally, and until the casting has been freed from its original intimate contact with the cavity wall the inevitable irregularities anchor the casting tightly even if the cavity is well tapered. Once the initial resistance has been overcome, of course, the draft facilitates ejection.

Designers of die-castings might well adopt the rule that "the cross-sectional area of an insert should not exceed the cross-sectional area of the metal."

Remote Engine Control

Abstracted from "Adaptability of Electronics to Aircraft Engine Control," by Joel D. Peterson and Robert W. Curran, Bendix Aviation Corp., *I.A.S. Paper*, January 1953.

BECAUSE MOST AIRCRAFT POWERPLANT controls are engine mounted, the problem of remotely positioning

the various specialized controls has become increasingly difficult. At present, the commonly accepted solution is a complicated network of cables and pulleys running between the cockpit and the engine nacelle; however, this is being superceded by an improved system which uses servomechanisms to coordinate the action of several engine controls. This does away with the complicated cable and pulley system with its associated difficulties and at the same time relieves the flight crew of the task of control coordination.

The basic servo system consists of four units: an amplifier, two synchros and a servomotor. The rotor of one synchro (transmitter) is mechanically linked to a cockpit control-lever while the rotor of the other is coupled to the input arm on an engine-mounted control. The equipment is electrically connected so that it produces an error signal which is proportional to the angular misalignment between the cockpit control-lever and the input arm on the engine mounted control mechanisms.

The error signal is fed into the amplifier where its magnitude is increased

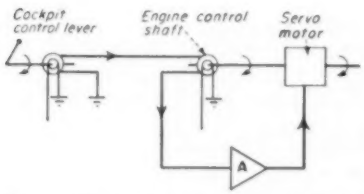

Fig. 1—Block diagram of remote torque control system.

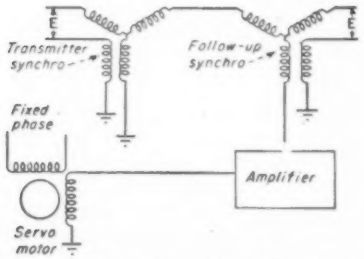

Fig. 2—Schematic wiring diagram of fundamental system. Servo motor mechanically positions follow-up synchro.

to a sufficient level to actuate the servomotor and associated control equipment, including the follow-up synchro. In Fig. 1 is shown the block diagram for such a servo loop.

System Operation

To produce a suitable error signal, the two synchros (transmitter and follow-up) are connected in series as shown in Fig. 2. With the rotor of the

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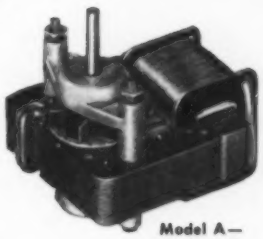
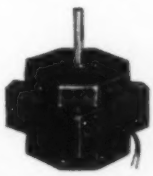

Model A—2-pole A.C. induction type

Model C—2-pole A.C. induction type

Model O—2-pole reversible capacitor type (for 6 or 12 or 24 volt A.C. only)


Model D—4-pole A.C. induction type

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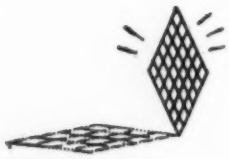

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transmitter synchro linked to the pilot's control lever and the rotor of the follow-up synchro coupled to the input arm on an engine mounted control, two voltage signals will be developed, each sensitive to the position of its associated equipment.

The two synchros are connected so that the voltages across the stators are in phase opposition and equal in magnitude when the cockpit control lever is properly aligned with the input arm on the equipment to be controlled. Full angular travel of the transmitter rotor is equal to the full angular travel of the follow-up rotor.

This produces an error signal that is proportional to any misalignment between the cockpit control lever and the input arm on the engine mounted control. If the two pieces of equipment are not aligned, one synchro voltage will be greater than the other causing the circuit to produce an error signal equal to the difference in stator voltages. The polarity of the signal will be determined by the phase relationship of the transmitter output to that of the follow-up.

Servo Motor

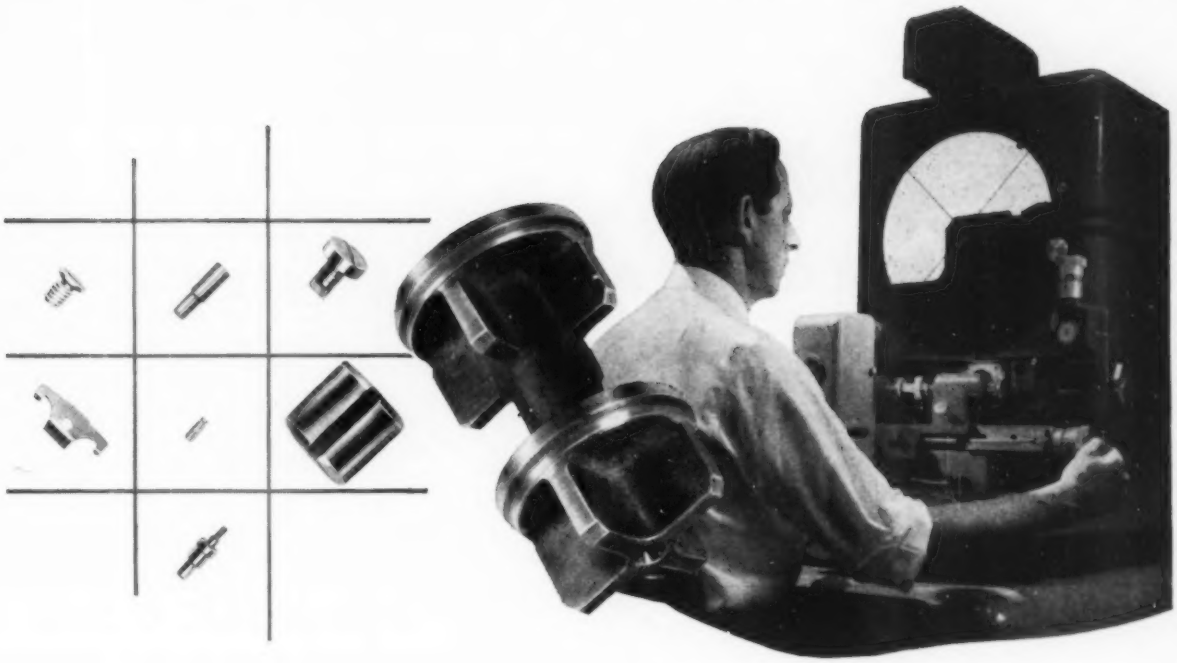
The servomotor consists of a two-phase, low inertia, induction motor, coupled through a suitable gear train to an output shaft. Both the motor and the gear train are chosen in accordance with the torque-speed requirements of the mechanisms to be controlled.

The fixed phase of the motor receives continuous a-c excitation of constant potential. The variable phase rereives its excitation from the output stage of the amplifier. Motor torque and speed are controlled by changing the variable phase excitation. The direction of rotation is governed by the relative phase angle between the fixed and variable phase excitation.

The phase relationship between the error signal, the output of the amplifier and fixed phase of the servomotor is such that the motor will drive in the direction necessary to eliminate the signal causing the motion. The motor will continue to turn until the rotor of the follow-up synchro, which is coupled to the motor, comes into alignment with the rotor of the transmitter synchro. At this time the cockpit control-lever and the input arm on the engine mounted control will be properly aligned.

Stabilization

Viscous damping by electrical feedback is used to insure stable operation of the torque control system. A rate



These parts help give Weston instruments their accuracy... they're checked on Kodak Contour Projectors

There is such a great variety of Weston instruments to measure all sorts of variables in all sorts of ranges that production on most individual items is small.

This creates a parts inspection problem. Precision requirements in many cases are so stringent that any measurable deviation from specifications is too big. Setting up toolroom instruments takes too long for the small volume of work being checked at any one time. Mechanical gages are even less economical at the low volume levels, and they just did not give the required accuracy on such jobs as checking the shoulder angles, concentricities, and specifications of the double-acting valve body shown above. (It goes in a recording thermometer and Weston makes it in many different sizes.)

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Possibly your inspection problems are volume and speed rather than the flexibility that Weston wants. In that case you will want to know about the Kodak Contour Projector, Model 3, which is designed for use with special staging fixtures instead of a moving work table. There is a field engineer in your area who can show you which model best fits your problem. To get in touch with him, just drop a note to *Eastman Kodak Company,* Industrial Optical Sales Division, Rochester 4, N. Y.

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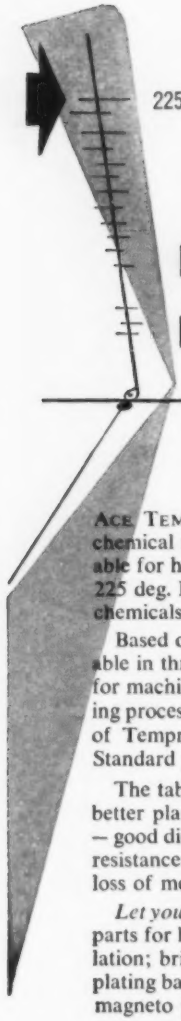

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Hardness—Durometer D	87	87
Impact, ft.—lbs./in.	0.41	0.49
Flexural Str., psi.	11,300	11,800
Dielectric Str., v/mil, 60 cyc.	400	460
Power Factor, 1 kc.	0.016	0.016
Dielectric Constant, 1 kc.	3.50	3.70
Water Absorption, (48 hrs. R.T.%)	0.12	—
Heat Distortion Temp., deg. F.	275	260

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signal, proportional to the rotational velocity of the servomotor, is fed into the amplifier in series with the error signal.

To accomplish this, a rate generator, whose armature is mounted on the same shaft as the motor, is added to the servomotor assembly. The rate signal is opposite in polarity to the error signal and of small enough magnitude that it becomes of importance only when the error signal is small. At that point, the error signal is approaching zero but the motor is still turning at high speed. When the error signal becomes less than the rate signal, the polarity of the total signal delivered to the amplifier is reversed and the corresponding excitation supplied to the variable phase of the induction motor is also reversed. This produces a braking action on the motor. System parameters are so arranged that as the error signal, the rate signal, and the motor speed all approach zero, the servo output shaft will come to the desired position without overshooting.

Since the magnitude of the error and rate signals is not large enough to accurately control the action of a motor directly, it is necessary to add an amplifier to the system. The amplifier must be capable of increasing the size of the control signal to a value sufficient to energize the variable phase of the servomotor. It is also necessary that it be phase sensitive.

This system has been used successfully on multi-engine aircraft to remotely control the position of such things as cooling flaps, carburetor mixture controls, throttle butterfly valves, and propeller governor or synchronizer settings.

Adhesives for Reinforced Plastics

Abstracted from "Adhesives for Reinforced Plastics," by H. A. Perry, Naval Ordnance Lab., presented at SPI Annual Conference, February 1953, Washington, D. C.

VARIOUS MEANS for assembling premolded plastic parts have been considered, such as threads, rivets, lock rings and adhesive bonds. The relative advantages of these are summarized in Table I. Mechanical attachments are not attractive because of the stress concentrations which are introduced which may exceed the bearing strength or the interlaminar shear strength of reinforced plastics. Also, sealing problems are introduced. An adhesive bond does a fair job of distributing stresses under load and with care it is possible to make a bond which is waterproof. Although leak

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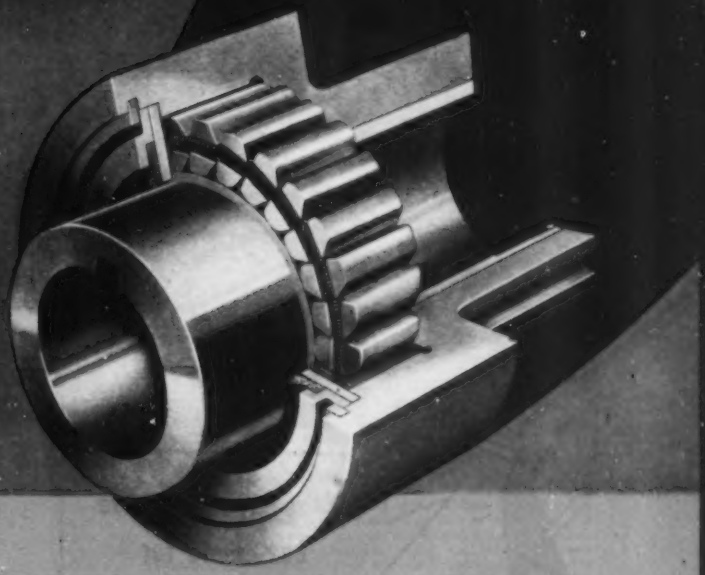

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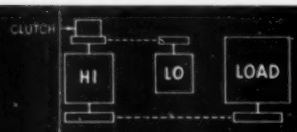

Typical Arrangement:

Drive is transmitted through clutch during low speed cycle. Clutch over-runs during high speed cycle.

INDEXING

Typical Arrangement:

Continuous rotary motion of crank A produces oscillation of arm B. Attached to outer race (or in some cases, the inner race) of clutch, arm B produces intermittent forward rotation of shaft C.

BACKSTOPPING

Typical Arrangement:

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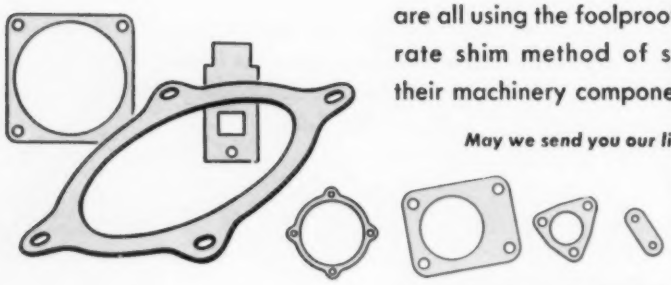

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Table I—Relative Merits of Attachments in Tubular Reinforced Plastic Structures

Design Factors	Adhesive Bonds	Metal Rivets, Bolts	Threads: Metal Lockings
Distribution of Stresses	Good	Poor	Poor
Additional Sealing Required Against Leaks	No	Yes	Yes
Electrical Conductivity	No	Yes	Yes
Magnetic Susceptibility	1	>1	>1
Requires Access to Interior of Closed or Reentrant Cavities	No	Sometimes	No
Susceptibility to Inspection for Defects in Materials and Workmanship	Poor	Good	Good
Time Required Before Joint May be Stressed	Up to 1 wk	None	None

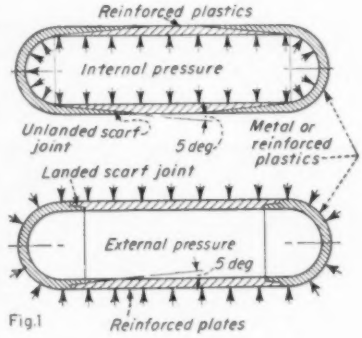

Fig. 1

tests may be made, adequate means are not yet available for the inspection and elimination of adhesive bonds which are defective mechanically.

At the present time, many ordnance prototypes are being assembled using landed scarf joints. Two typical geometries are shown schematically in Fig. 1. It should be noted that flushed type scarf joints are employed for the assembly of rolled reinforced plastic tubes and molded reinforced plastic or metal end closures. In housings which are subject to internal pressure, and which contain metal end closures, the joint is designed so that the rigid metal is on the outside of the joint. Thus, the more flexible plastic will be pressed against it, stressing the adhesive in compression and shear rather than tension and shear. The reverse is recommended for housings subject to external pressure. Scarf joints are landed in structures subject to external pressure and/or large compressive loads. Lands also provide lengthwise dimensional control and axial alignment during the assembly of the parts. In some applications where tensile loads are not great, it is possible to use landed sleeve joints instead of scarf joints; however, it is thought that when tensile loadings are large, as in pressure vessels, an unlanded scarf joint between adherends

of like elasticity gives a more equitable and efficient distribution of stresses over the cross section of the adherends than does a landed scarf joint.

The role of the angle of a pure scarf in a tubular joint between like materials has been tested to a limited extent. On the basis of theoretical considerations, assuming that the adhesive in the bond is equally strong in all directions, the strength of the bond should be very nearly proportional to the bonded area. Discrepancies are attributable to differences in stiffness between the adherend material and the adhesive. This is confirmed as a first approximation by the results shown in Fig. 2 in which the angle of the scarf was varied.

The role of difference in the stiffnesses of the adherends in metal to reinforced plastic tubular scarf joints is also being studied. Since the elasticity of the laminate is about ten times that of steel, or about three times that of aluminum, the plastic will pull away from the metal if stressed in tension,

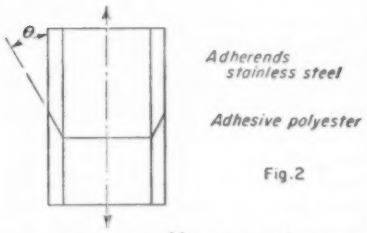

Fig.2

Angle of scarf, deg	Tensile[1] load at fracture, lb	Bonded area, sq in.	Average unit stress, psi
90 (butt)	2,760	0.64	4,320
60	3,190	0.74	4,320
30	4,710	1.29	3,650
5	25,200	7.37	3,420

(1) Average of four specimens

Strength of scarf joints vs angle

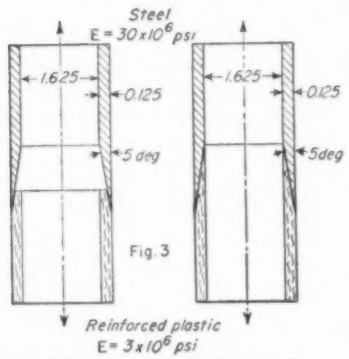

Fig.3

Truncated Scarf	Simple Scarf
Area: 2.48 sq in.	4.96 sq in.
Load at fracture 8,000 lb	8,800 lb

Influence of truncation of plastic on strength of metal to plastic tubular scarf joint

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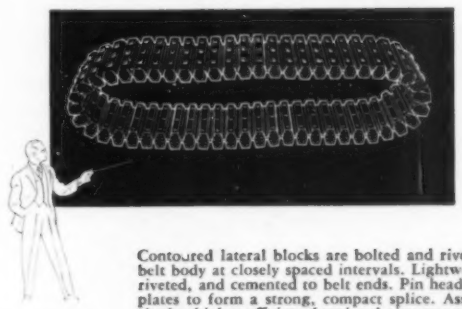

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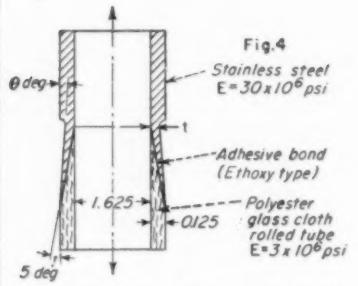

Relief angle θ deg	Relief thickness t, in.	Load, lb	Computed average stress in adhesive, psi	Unit stress in steel, psi
0	0.094	10,400	2,100	19,770
148	0.071	12,900	2,600	33,160
287	0.047	13,100	2,630	50,000

Influence of relief on the strength of metal to plastic tubular scarf joints

leading at a low stress level to progressive failure of the bond which is initiated at the thin end of the metal part of the joint. This is confirmed in Fig. 3, in which a complete metal to plastic scarf was approximately as strong as a similar joint, in which the plastic part was truncated. It was thought that the apparent strength of the metal to plastic scarf joint might be increased if somehow the metal part could be made to behave as though it were more elastic. This is demonstrated by Fig. 4 in which the metal part was relieved, leading to a 25 percent increase in strength.

Some comparative data have been accumulated on the influence of adhesive film thickness and on the rate of loading on the tensile strength of tubular scarf joints. Table II indicates no significant difference in the static strength of scarf joints between interference fits and 8 mil clearances. Clearances in excess of this have not been studied thoroughly, however, some practical experience with large clearances suggests that the apparent static strength of the adhesive declines if the film thickness is very great.

The results given above were ob-

Table II—Static Strength vs. Adhesive Thickness

Type of Adherends	Scarf Joint Clearance	
	Interference	8 mils
Aluminum to Polyester Laminate	1,800 psi	1,800 psi
Polyester Laminate to Polyester Laminate	1,600 psi	1,700 psi

Table III—General Properties of Common Adhesives

Type of Adhesive	Cure Shrinkage, Percent	Adhesion	
		To Metals	To Reinforced Plastics
Resorcinol	10	Requires primer	good
Furane	10	fair	good
Ethoxy	2	excellent	good
Polyester	7–9	good	good to polyester; poor to phenolics
Thiokol	low	fair	fair

tained in a conventional tensile test machine at a slow crosshead speed of about 0.05 per minute. Other results on similar specimens were obtained in a drop test rig at a striking velocity of 25 ft per sec, or 360,000 times faster than in the tensile test machine.

Table III shows the general properties of some room temperature setting adhesives which are now available. Although the resorcinol type contains a solvent, it is included because the adhesive, if dried to a certain extent before assembly, will cure between impermeable adherends. In view of the good compatibility of polyester resins with propellants and explosives and in view of the opportunity to mix various rigid and flexible polyester resins which permits some adjustment of the elastic constant considerable attention to date has been directed toward polyester adhesives. However, some applications do not call for good compatibility between adhesive and hazardous materials, and for these applications the great strength developed by ethoxy resins and their low shrinkage during cure are of considerable interest. For ordnance applications, an ideal adhesive would probably have the following characteristics:

(1) Coefficient of thermal expansion should be equal to or a compromise between those of the adherends. When this is possible, the thermal stresses in the interface due to heating or cooling will be at a minimum;

(2) Cohesive strength of the adhesive, and its adhesion to steels, brasses, light alloys and reinforced plastics, should be as great as possible and, from a practical viewpoint, should be not less than one-tenth of the cohesive strength of the adherends. Under this condition, the length of

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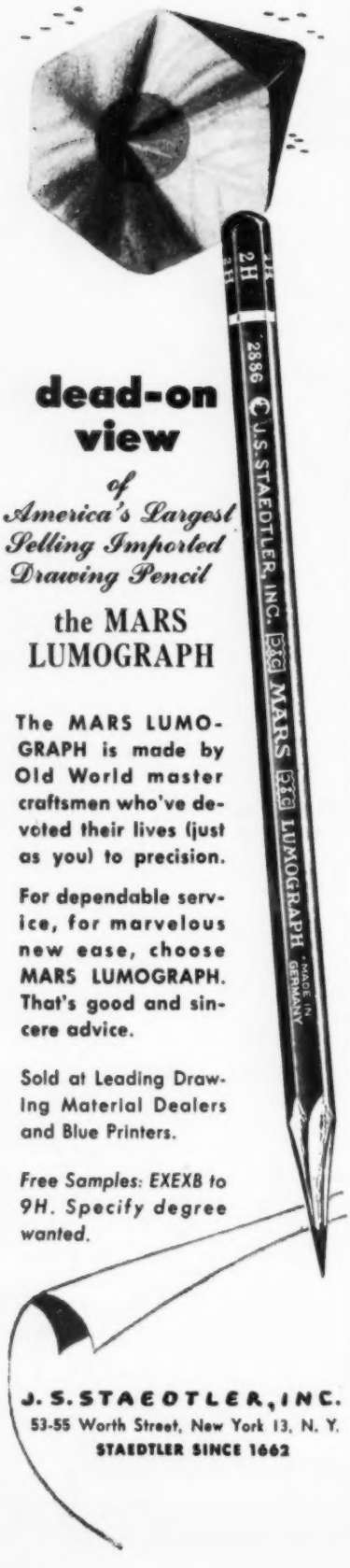

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overlap or the angle of scarf required for an efficient joint will be within reason;

(3) Adhesive should not shrink during cure, so that internal stresses will not be generated during cure;

(4) Adhesive should not require extraordinary cleaning procedures and special surface treatment and should spread readily;

(5) Adhesive should cure to full strength between permeable adherends in a short time, preferably without the use of external heat;

(6) Cohesion, adhesion and elastic constant of the adhesive should not be affected to any great extent by variations of temperature from —65 F to 165 F. Also, the adhesive should not be affected to any great extent by immersion in sea water or exposure to humid atmospheres for long periods of time;

(7) Cured adhesives should not react with the ingredients of explosives or propellants.

(8) If like adherends are to be bonded, the elastic constant of the adhesive should be equal to those of the adherends so as to minimize stress concentrations in the bond.

(9) If unlike adherends are to be bonded, the adhesive should be quite flexible so as to accommodate differential deformation in the adherends under stress.

"COMPULSORY RETIREMENT is not fair to the man who is still doing a good job, nor is it sensible to rob the company of that man's talents which are the result of years of experience." This was the opinion expressed by Joseph J. Morrow, director of Personnel Relations, Pitney-Bowes, Inc. to the American Management Association. Instead, the Pitney-Bowes man urged a selective examination of employees who reach the retirement age so that they can use their experience and mechanical know-how to good advantage.

ASME MEMBERS are eligible for three "Machine Tool Design and Economic Awards' made available by National Machine Tool Builders Association. Papers of 2,000 words or more representing original work of submitting member can deal with design or application problems of machine tools, their effective use in reducing production costs or increasing accuracy of work, or economic importance. Manuscripts must be received at Society Headquarters, 29 W. 39th St., N. Y. 18, N. Y. by June 30, 1953.

DESIGN CHANGE TO STEEL CUTS WEIGHT 50%

MANY machine designs can be simplified by proper application of welded steel construction. Less material is needed since steel can be formed at low cost to efficient engineering shapes. Steel requires less machining and often eliminates such operations as milling and drilling required with conventional castings.

At Ilg Electric Ventilating Co., Chicago, Illinois, changing over this end bracket to steel provides several distinct advantages. Material cost has been cut considerably as only half as much metal is needed. Also pound for pound steel costs less than gray iron. After welding components in a simple fixture, the only machining that remains is to drill seven holes. Former milling operations are eliminated.

Although half the amount of metal is needed with steel, the part is actually stronger and more rigid than the original construction. It is easier to clean and paint and costs 30% less to produce.

Fig. 1. Former design *of machine part required milling and drilling. Weighed 18 pounds, twice as much as steel design.*

Fig. 2. Present construction. *Components are sheared and brake-formed from steel, held in simple fixture for welding. Bearing housing and arms are 10 gauge metal. Weighs only 8½ pounds. Cost is 30% less.*

Machine Design Sheets showing how to simplify designs and cut costs are available on request. Designers and Engineers write on your letterhead to Dept. 1303.

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CLEVELAND 17, OHIO
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Mobile Lab Aids Defense Contractors

FIRST MOBILE GAGE TEST LAB saves Detroit Ordnance District suppliers time and expense by close and frequent check on precision gages. Equipped with the latest testing facilities, trailer-lab runs on a regular routing schedule bringing gage-testing tools directly into manufacturer's plants. First use of the lab's facilities was at the Plymouth, Michigan plant of the Evans Products Co.

Numbered among the trailer's equipment are 86 small gage-testing tools. Larger pieces of equipment, include an Eastman contour projector, Pratt & Whitney measuring machine, three granite surface plates, a Sheffield comparator, a super micrometer, three sets of gage blocks and an internal diameter checker.

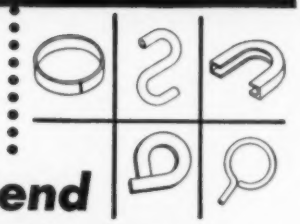
Weighing just under five tons and carrying a crew of three technicians, the cost of the trailer and its equipment is about $60,000. Construction is similar to that of a refrigerated truck body.

Wired for 110-volt operation it takes electrical power from any plant lighting system and can be operated either inside or outside a plant. Inside the trailer is a compact laboratory roughly 26 ft long, 7½ ft wide and 7 ft high. It is completely air conditioned and carries its own heating system.

Conceived by the Detroit Ordnance District, the lab has three major advantages: (1) It makes possible large savings in production time by bringing gage-testing facilities right into a plant; (2) because of its scheduled calls and closer check on precision gages, sizeable savings can be realized through the reduction of parts scrapped because they do not come up to the close tolerances required of prime contractors; (3) a regular schedule of visits to plants in the District's area keeps production men constantly aware of the need for close watch over the accuracy of their production machinery and its products.

In addition to keeping a close check on gages used in military output, the mobile Ordnance lab is also equipped to repair and certify gages. (Army Ordnance inspectors keep records of the number of times a gage is used, the kind of material it tests, and the probable life expectancy of a gage. The itinerary of the trailer lab can be changed to conform to schedules determined by these records.)

The trailer's facilities are also made available to smaller contractor-plants near each of the six major Ordnance production centers. The regular driver of the tractor that accompanies the trailer brings gages in from these



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Simple and complex bends can be formed and duplicated in many ductile materials with a versatile Di-Acro Bender. Bending capacity of the five hand operated models ranges from 1/16" wire to 1" round mild steel bar. Many accessories are available for bending various materials and shapes. The Di-Acro Bender can be delivered completely tooled for most forming requirements in solid materials and tubing.

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DI-ACRO HYDRA-POWER BENDER

A universal hydraulically operated bending machine that is equally as flexible as hand operated machine. Di-Acro Hydra-Power Benders are especially designed for those long runs and heavy bending operations which are impractical for manually operated equipment.

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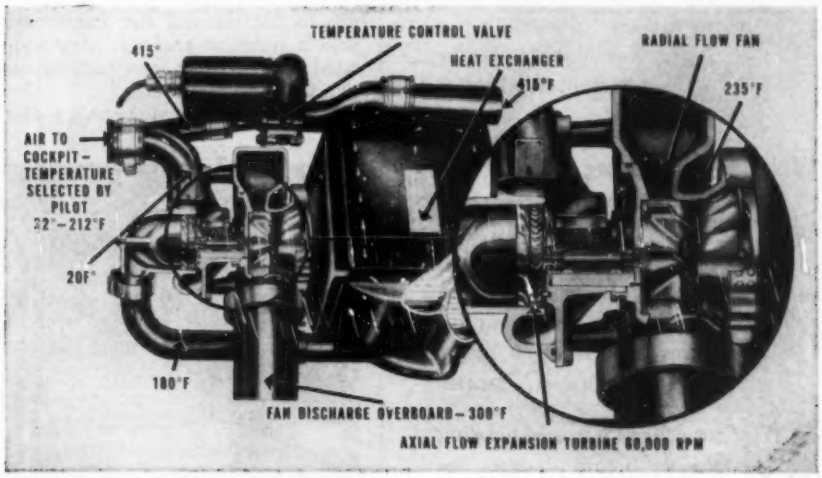
di-acro PRECISION METALWORKING MACHINES

Designers:

Can you help solve this problem for tomorrow's planes?

Problem: Cockpit temperature of present day jet aircraft flying 600 m.p.h. at sea level would reach 190°F. (caused by a combination of compression, friction of plane's skin with air, solar radiation, electrical equipment and pilot's body heat). How to reduce this temperature to a safe, comfortable level with equipment of minimum size and weight, yet capable of withstanding extreme conditions of heat and cold, erosion, corrosion, and numerous mechanical stresses which occur in high-speed flight?

Our Answer: A compact, 20 lb. unit, developed by Hamilton Standard engineers, in which some 25 different basic metals and alloys are used. It bleeds air from the engine compressor at approximately 415°F. . . . extracts 150,000 b.t.u.'s per hour by feeding it through a heat exchanger and 60,000 r.p.m. expansion turbine wheel . . . delivers 120 m.p.h. blast at desired temperature that changes 60 cu. ft. of cockpit air every 15 seconds. The unit also provides means for heating and pressurizing cockpit at high altitudes.



What's Your Answer? Our cockpit cooling unit is operating with excellent efficiency in many of today's jet aircraft. But in order to solve similar problems in the much faster flying planes of tomorrow, we will need new ideas, new designs, entirely new systems.

At Hamilton Standard there are many other challenging projects for designers, too. This unit is only part of a growing line of jet aircraft equipment which already includes turbine engine starters, fuel controls, hydraulic pumps, and auxiliary drives and controls for guided missiles. There are also many exciting new developments in world-famous Hamilton Standard propellers.

Creative Engineering Pays Off at Hamilton Standard

We're always looking for ideas – and at Hamilton Standard ideas pay off. A majority of our company executives are engineers. We have a technical staff of more than 250 now – young, capable, progressive leaders – and we need more to meet the largest research and development program in our 33 year history. If you are one of the designers we're looking for, there's a bright future for you at Hamilton Standard.

There's a Future at Hamilton Standard

for Designers

with 3 to 10 years' experience in actual design of mechanical parts (not necessarily in aircraft field – machine tool, electrical, automotive or automatic machinery could be just as valuable). Engineering degree helpful, but not necessary if practical experience is adequate. Knowledge of mechanics, mathematics, strength of materials, thermodynamics or hydraulics would be desirable but *experience in machine design is the essential requirement.*

for Analytical Engineers

with an engineering degree and at least 2 years' actual experience as design analysts. Knowledge required either of mathematics, mechanics and strength of materials, or of mathematics and thermodynamics.

These Positions Offer

- Excellent pay and a fine chance for advancement based on ability.
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Hamilton Standard

Division of United Aircraft Corp.
Windsor Locks, Conn.

DON'T get your neck in a NOOSE!

Use Milford's scientific approach to your fastening problem.

If you were solely responsible for recommending a machine tool for your company's production needs, you'd make pretty certain that your choice would perform correctly, efficiently, with the lowest possible dollar expenditure. Right?

It's important, too, to do likewise in recommending fasteners and functional components that may be cold-headed. Millions of dollars yearly are wasted by not giving these parts . . . at the design stage . . . the same careful scrutiny that is given major production equipment.

Why not consult our cold heading engineers before designs are "frozen" . . . while planning is fluid enough to save you excessive costs?

EST. 1919

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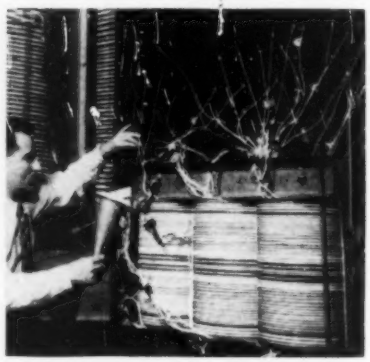
smaller plants for testing.) The trailer and its crew spend about a week at each Ordnance District supplier plant along its route, offering these manufacturers the very latest facilities and stressing the need for periodic checking of precision tools.

Actually, the idea of a mobile test lab is not new. The adaption of gage testing facilities, however, brings the concept of a moving laboratory into the field of industrial mass production. The U. S. Army uses a mobile lab to conduct tests on materials going into road and airfield construction (Prod. Eng., June 1951, p. 179).

Transformer Models Pay High Dividends

ELECTROMAGNETIC MODELS to determine transient voltages in large transformers supply voltage magnitudes and wave shapes accurately before the actual transformer is designed. General Electric's Power Transformer Dept. points out that previous method was to test the full size transformer with a transient analyzer. Any indicated changes were then both expensive and time-consuming.

It is claimed that using this testing



ELECTROMAGNETIC MODEL compared to full size 33,333 kva, three-phase transformer. Test measurements indicate maximum voltage deviation between some parts on model and actual unit to be only 4.3 percent. Model is 1/6 the size, 1/216 the weight and was built in 1/10 the time.

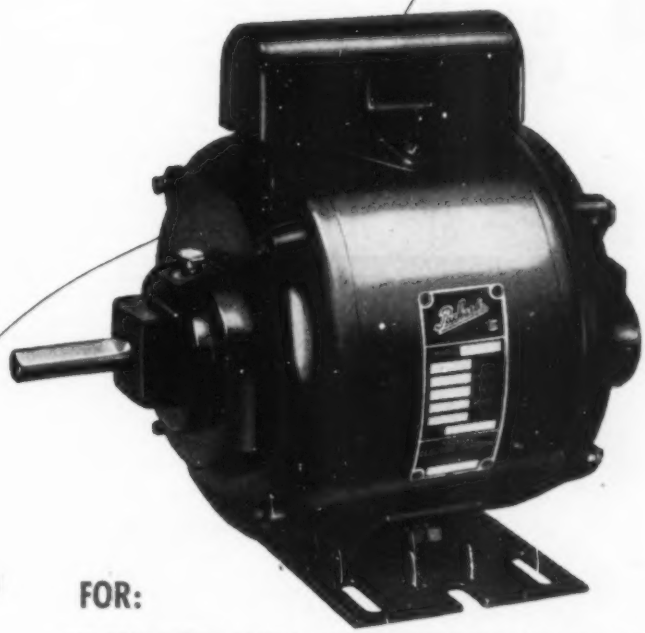
technique will lead to the construction of transformers with more efficient use of insulation and more exacting application of materials and space. Failure prediction is another big advantage.

To be built for most transformers rated 100,000 kva and above, and all units having complicated winding designs, the model will require only a fraction of the time and cost of a large transformer.

GET THE FACTS... see why

more and more appliance makers choose

PACKARD ELECTRIC MOTORS



The makers of motor-powered products gain in *three ways* when they choose Packard Electric motors specially adapted for use with their products.

First: Manufacturers get the *right* motors for *their* products . . . motors that fit the space, provide correct starting and operating torques, and have the proper construction for long service.

Second: Packard Electric motors are so dependable they help keep customers satisfied, help reduce complaints and servicing, and actually help increase product sales.

Third: Manufacturers get these specially engineered motors at low cost . . . due to Packard Electric's tremendous facilities for volume production.

So, if you have any motor problem, call on Packard Electric. Let Packard's engineers show you how you can gain with Packard Electric motors.

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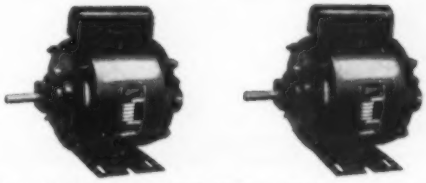
VENTILATING UNITS • MILKING MACHINES • CREAM SEPARATORS



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DEPENDABLE APPLIANCE MOTORS FOR THIRTY-SIX YEARS

GM GENERAL MOTORS

Packard

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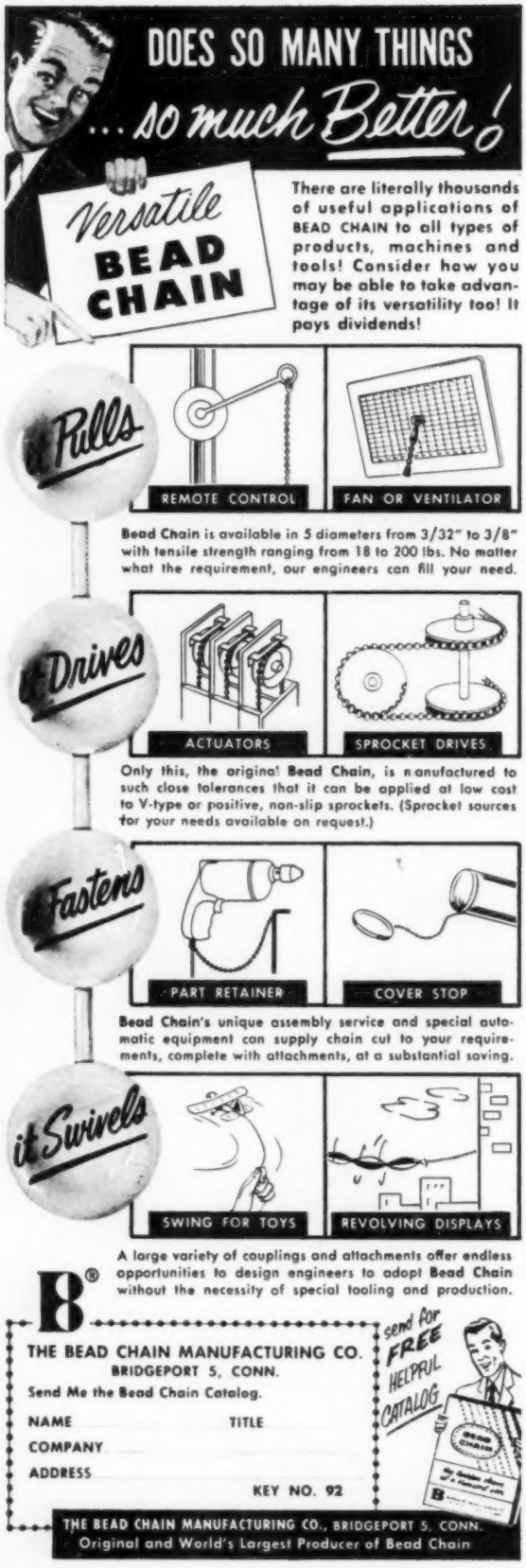
Packard Electric Division
General Motors Corporation
Warren, Ohio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Bead Chain's unique assembly service and special automatic equipment can supply chain cut to your requirements, complete with attachments, at a substantial saving.
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OUR READERS SAY

Wants Better Training Program for U. S. Engineers

To the Editor:

Several of us have reviewed in careful detail the article "Tough Training Backs Russian Engineers" in *Product Engineering* for February 1953, and are gratified to note the realistic manner in which the subject of engineering training in Russia is presented.

The information obtained from Russia directly, as indicated in your article, runs quite parallel to material included in "Scientific Manpower Behind the Iron Curtain" by Dr. David Rodnick, whose paper was read before the 1951 AAAS Conference on Scientific Manpower on December 28, 1951.

Your presentation, however, is much more graphic, the illustrations and captions adding greatly to the story—even though an embryonic machinist with open frock is shown risking his life near a milling machine cutter in one photo.

For some time we have counted ourselves among those who are concerned with the realization that Russia, far from having an exclusively agrarian economy, is making rapid progress toward a very realistic modern industrial economy as well. There are a host of references in the literature indicating Russian plans, and critical examination of Russian built machinery in reference to the work it is intended to do, clearly indicates their accomplishment in this direction. All of which emphasizes the important consideration that we, in America, are not pressing as we should for the continual and competent training of adequate numbers of young engineers and scientists so vitally necessary to develop, maintain and exploit our own growing industrial economy. Your article on Russian education, as well as your editorial on German training in the same issue, tends to emphasize this weak point in our thinking, and we compliment you for the courage you have in calling it publicly to attention.

We, ourselves, are at present getting together similar material which we propose to present to those who may be willing to talk with us on this

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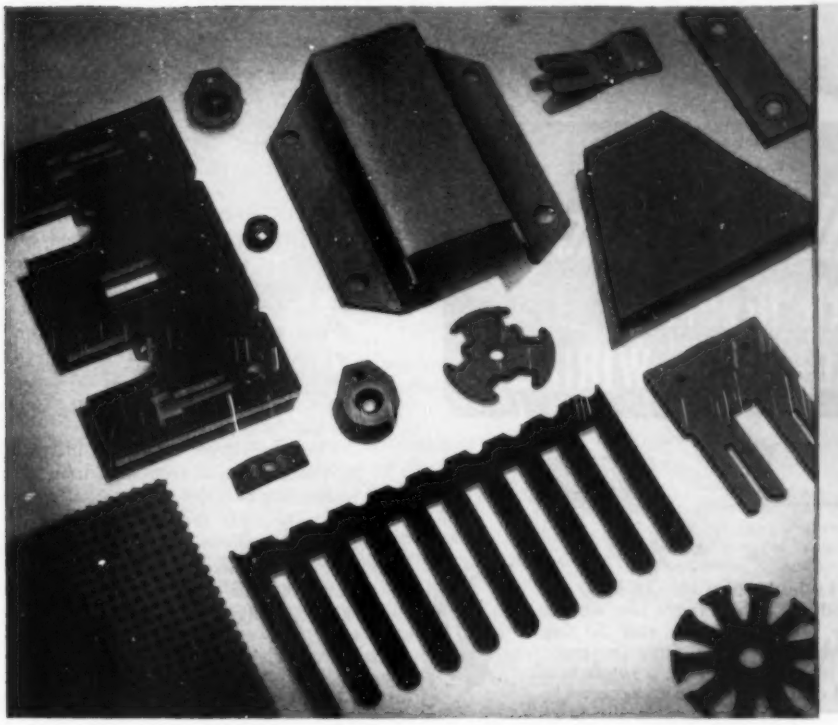

SPECIFICATIONS

Thickness Range:	.005" to 1"
Finish:	Pressed and calendered
Punching:	To 3/16" thick
Sheet Size:	56" x 90"
Roll Width:	56" for thicknesses of .005" through .060". Coils to 3/16" for thicknesses of .005" through .090".

PROPERTIES

Mechanical	
Flexural Strength	
(Lengthwise)	14000 psi min.
(Crosswise)	12000 psi min.
Tensile Strength	
(Lengthwise)	7500 psi min.
(Crosswise)	5500 psi min.
Compressive Strength	
(Flatwise)	20000 psi min.
Izod Impact Strength	
(Lengthwise)	3.5 Ft.-Lbs./inch
(Crosswise)	2.9 Ft.-Lbs./inch
Electrical	
Dielectric Strength	
(1/32" thick)	250 min.
Short Time Test	
(1/8" thick)	175 min.
Arc resistance, seconds	100

Make it from turned rods. Diameters from 1/8" to 1" with ground or buffed finish.

Make it easy for yourself when you're buying vulcanized fibre. Call your Taylor engineer . . . he will be glad to work with you . . . help select the correct grades to fit your needs —Commercial, Bone, Super White, Abrasive and Built-up. Also ask him for samples of Taylor Laminated Plastics . . . *Phenol, Silicone and Melamine Laminates* . . . suited for a variety of your product requirements.

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"PACKAGED WIRING!"

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We design and manufacture harnesses in any required wiring arrangement, with such attached units as terminals, relays, limit switches, push-button stations, circuit breakers, junction blocks, etc. They meet the most rigid requirements, including those for aircraft and ordnance, and we have produced them for leading manufacturers of electrical and electronic equipment. We can do the same for you!

Our Engineering and Experimental departments are at your service for the solution of all of your product wiring problems. Send prints or details of your problem for prompt engineering recommendations and a firm quotation, without obligation.

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general subject. In due course, we intend to ask for the loan of the original prints of pictures on page 204, and the picture to the right on page 206, and finally, for permission to quote from the text of your fine article.

While we are in the bouquet mood, I would like to express on behalf of several of my colleagues here in the Caterpillar Research Department, that your magazine contains excellent general technical reading. It is fairly well worn by the time it is returned to our library for final reference purposes.

—R. J. FURSTOSS
Caterpillar Tractor Co.

Uni-Directional Drive Not New

To the Editor:

Regarding the Uni-Directional Drive in Mr. Rappaport's article on "Modified Geneva Drives and Special Mechanisms", February, 1953, page 175, it is novel, but not new. This type of drive was used on a programming device designed by us in 1950 and is currently being produced as a component in certain Ordnance equipment. The idea was conceived by a Mr. L. A. Sheldon, a Design Engineer of our organization, and he informs me that he had previously seen this type of drive used on a photo-electric recorder made by G. E. and on various devices before that.

Our drive was used not primarily to produce uni-directional drive, but to produce two different output speeds when the input speed was constant but reversible. In our case a split field motor was used on the input, and a simple switch was all that was necessary to change the speed of the output shaft.

—J. W. LEET
General Electric Co.

Needs Movies For Engineering Department

To the Editor:

We are wondering if you could make a recommendation in the way of giving us a list of movies that are available that would be of educational value for showing to our engineering department.

Probably you can direct us to some catalog that would give us this information or probably your office has a list of some such movies.

—W. E. GUNNERSON
Anderson Bros. Mfg. Co.

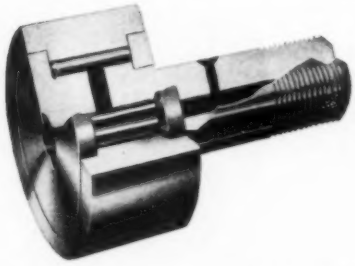
Ed—Sorry, but we do not keep a list of industrial movies that are available for showing to engineering depart-

CAM ACTION IMPROVED with MULTIROL® BEARINGS

under heavier loads • with shock resistance • and space economy

Modern demands for faster, more automatic machines necessitate a new approach to cam action efficiency. Improvised bolt and roller units are no longer adequate for this mass production machine age.

Machinery manufacturers are finding that even at slow speed, it is difficult to carry the usual heavy radial and intermittent shock loads of cam application efficiently on plain bearings or standard anti-friction ball and roller bearings. With increasing speeds, and lubrication limited by the desire for simplified design, the plain bearing wears excessively and fails early. Ordinary ball or radial roller bearings used on a shaft as cam followers have a



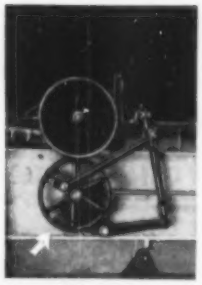
tendency to split in the outer race because of the excessive strain on the thin and superhard race sections.

One bearing that has proven particularly successful in cam follower applications is the Multirol CF series full type roller bearing. This bearing is built especially for the repeated shock loads of typical cam action operations. The outer race section is not only heavy radially but is also martempered to combine maximum toughness with adequate surface hardness for withstanding the punishment of cam applications. The outer ring operates on a full complement of small diameter rollers so the load is evenly distributed over a greater bearing surface. The inner race and flange are made in a single piece with the stud, preventing any possibility of disassembly in operation. Greater accuracy is maintained throughout longer bearing life and, compared with plain bearings, both starting and rolling friction are reduced to a minimum. As a result internal wear is diminished and power requirements of Multirol bearing equipped machines are appreciably lessened.

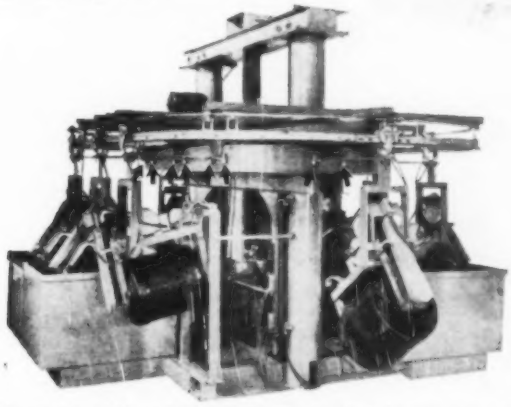
Load Capacity Comparison

To illustrate the increased capacity of the Multirol CF, here is a comparison between a Multirol CF-1 bearing and a corresponding friction type roller, making use of the maximum permissable bearing pressures in pounds per square inch of projected area. The CF-1 bearing will have a maximum of 2240# while the equivalent friction type roller would have a capacity of less than 400#.

What This Means in Terms of Performance



The James Hunter Machine Co., of North Adams, Massachusetts replaced units consisting of a standard roller bearing and hardened roller with Multirol CF bearings on eccentric cams that actuate rake teeth in their wool washers. The changeover reduced their original and replacement costs over 10% and reduced maintenance to occasional lubrication. Where previously, rollers only lasted a maximum of several months, no replacements have been required with the Multirol bearings. As a result, the Multirol Bearings solved a trouble spot that brought in many customer complaints.



Crown Rheostat and Supply Company of Chicago uses up to 200 Multirol Cam Followers as guide and support rollers in the travel and transfer mechanism of their cleaning, plating, and drying machines. Formerly trolleys were suspended from rails but the cam follower units proved to be a more precision means of friction reduction and added stability to the supporting arms.

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A new 140-page Bearing Reference Guide complete with 30 pages of vital engineering data has just been released by the McGill Manufacturing Company. It has the full story on the advantages of Multirol CF Bearings as well as information on the Multirol CYR, Multirol SE and Guiderol Bearings. Send now for your copy of McGill Catalog No. 52.

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ments and group meetings. However, we feel that you can get quite a few by contacting some of the technical societies. They are: American Society of Tool Engineers, 10700 Puritan Ave., Detroit 21, Mich.; American Society of Mechanical Engineers, 29 West 39th St., New York 18, N. Y.; Society of Automotive Engineers, 29 West 39th St., New York 18, N. Y.; and Mr. Frank La Que, International Nickel Co., 67 Wall St., N. Y.

We Stand Corrected

To the Editor:

We liked the treatment you gave the Buick in your new car edition, but how did you ever mistake a Buick Special for a Roadmaster on page 162?

—JERRY RIDEOUT
Buick Division
General Motors

Ed—At the last minute we switched pictures, deciding to use the Buick Special on page 162, because the Roadmaster was already pictured on the cover. Unfortunately, we forgot to change the name in the caption at the same time.

Wants to Reprint Article

To The Editor:

We would appreciate your granting us permission to reproduce pages 120, 121, 122, and 123 of your article, "Fatigue Properties of Cast Aluminum Alloys" in the May 1952 issue of *Product Engineering*. Approximately 15 copies of each are needed for use by our engineers, and of course none would be sold nor given to anyone outside our company. —L. P. BRADLEY,
McDonnell Aircraft Corp.

Ed—We are glad to extend to you permission to reproduce pages 120 to 123 inclusive of the May 1952 issue of *Product Engineering*.

Eighteen Years Old And Still in Demand

To the Editor:

In October of 1934, you published an excellent article by Mr. John W. Harper on "The Significance of WR^2 and How to Calculate It." This article is very much in demand in the Application Engineering Section of our factory at Dayton. They have asked me to see if I can get a hold of an original for reproduction purposes or half a dozen photostatic copies.

Heavy-duty Model 1065 shown. ⅓ to 2 HP, 3.8 to 21 CFM, 10 to 30 PSI. Direct or V-belt.
Light-duty Model 0440 shown. ¼ to ⅓ HP, 2 to 5.6 CFM, 7 to 20 PSI. Direct or V-belt.
Integral Motor—Pump Model 0210, ¼ HP, 1.3 CFM, to 25 PSI.
V-belt Dual Chamber 10x1040. 9 CFM each side, vac. to 20", pres. to 20 lbs.

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see our catalog in PRODUCT DESIGN FILE or write for copy

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HERE'S WHAT THIS CAN MEAN TO YOU:

Twin City's experience, plus its ability and willingness to work with your engineers to cut your costs and give you top die casting value, can help you show *new profits* on the products you sell. Oldest die casters in the upper Midwest, Twin City offers a dependable history of service and technical excellence.

Write for the facts or send sample or blueprint. Let Twin City demonstrate its *service plus* to you.

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If you can lend me an original, the factory will be pleased to reproduce same and return it to you.

—L. H. BERKLEY
The Master Electric Co.

Ed—We are forwarding you a photostat negative of "The Significance of WR^2 and How to Calculate It."

You will be interested to know that because of the persistent demands for extra copies of this article, which demands have extended over a period of eighteen years, we are reprinting the article and including it in the *Annual Handbook of Product Design*—1954. The Handbook will be issued to the readers in November of this year.

Wants Demonstration of New Tracer Attachment

To The Editor:

In regard to the following article on page 142 in the January, 1953 issue of *Product Engineering*, we would like to have a demonstration on this tracer attachment:

3. Oerlikon Machine Tool Works, Buehrle & Co., Zurich, Switzerland, uses a moving hydraulic power cylinder. A pilot valve operated by the tracer supplies hydraulic fluid to the proper side of the piston. Main difference between the Oerlikon and the Dubied is in the design of the pilot valve.

—STEPHAN TRUCHAN
Gary Welders

Ed—For more information contact Mr. F. Chatuisat, Box 3049, Ashville, North Carolina.

Don't Blame The Ghost Writer

To The Editor:

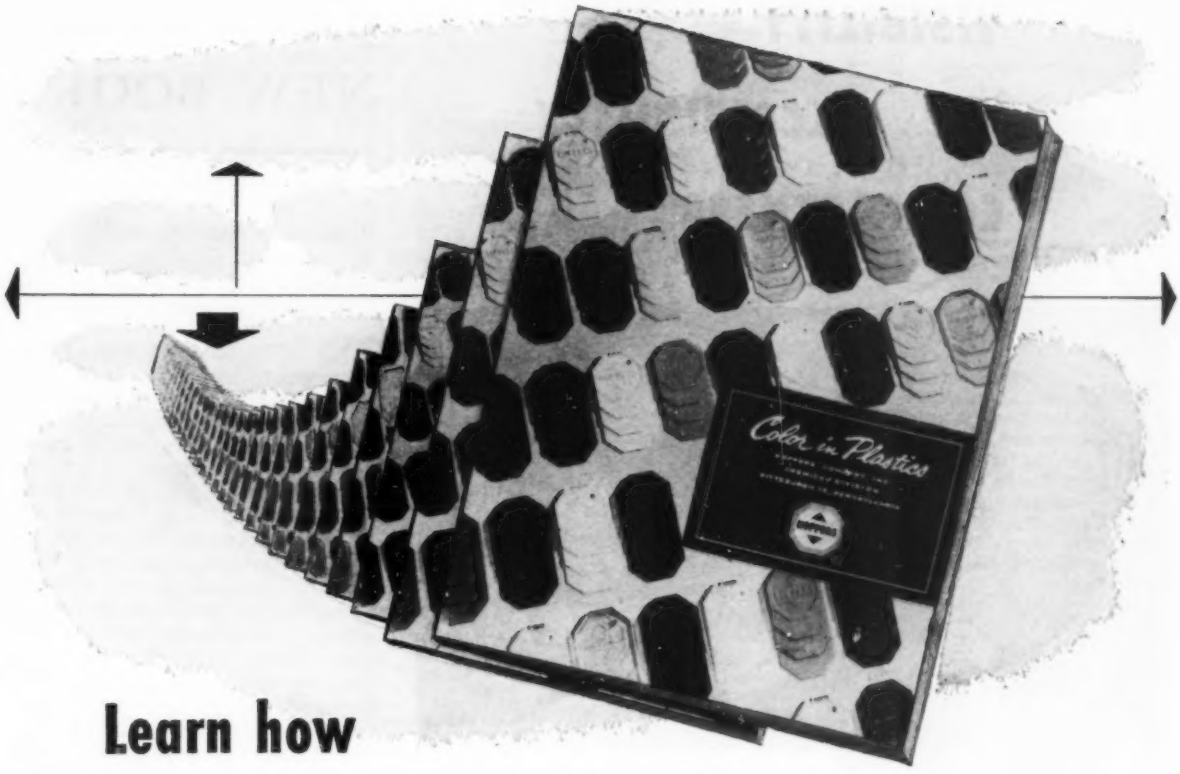
Just finished reading your editorial "The Chariot to Fame and Glory" appearing in *Product Engineering* for January, 1953.

It sounds as if someone made a speech somewhere which departed to an insufferable degree from the sort of thing you and I would feel was acceptable copy.

Who, for heaven's sake, did what and when—and did he have a ghost writer? If so, perhaps we ought to unite to see that it doesn't happen again.

—L. H. CHURCH

Ed—Yes, someone made a horrible speech in that it was full of new jargon. He did "take in" a few people, but then he was "taken apart." We too hope it doesn't happen again, because it is embarrassing, especially when he doesn't have a ghost writer.



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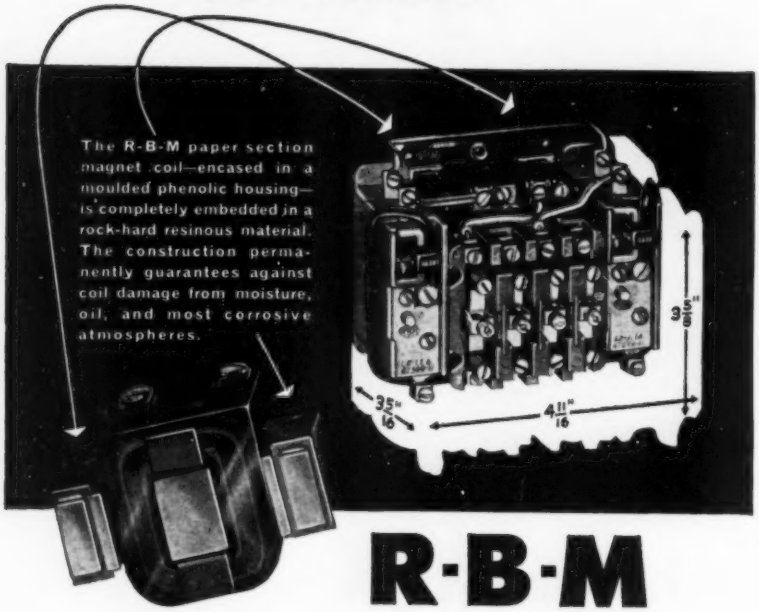
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MANUAL AND MAGNETIC ELECTRIC CONTROLS
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NEW BOOKS

Pressure Vessel Manual

KARL SIEMON, 5½ x 8½ *in.* 284 *pp. Published by Edwards Bros., Inc., Ann Arbor, Michigan,* $3.85.

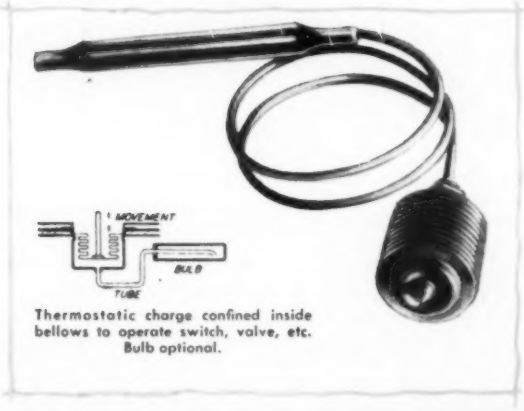
The design of pressure vessels has undergone a great change in the past two decades. The rapid increase in the pressures and temperatures employed started engineers and scientists on thorough investigations of the stresses in pressure vessels and compelled them to adapt more exact methods of computation, to produce an economic and safe construction. Most of these investigations are scattered throughout the periodicals and transactions of engineering societies and other scientific papers and are, therefore, not readily available. The different design and safety codes which were formulated as a means of accident prevention, have remedied this situation to a certain extent. But they give rules and formulas applicable to certain materials only and presuppose a familiarity with the fundamental theories. The rapid development of new alloys and materials of construction, and some special cases, however, require a thorough knowledge of the basic problems. In this book an attempt has been made to give for each of the different elements entering into pressure vessel design an analysis of the problems involved and a brief discussion of the methods suggested for the calculation of the stresses. Numerous references to original papers have been given to serve as a guide for further investigation of certain special problems.

In this fourth edition, the code requirements have been brought up to date and conform with the 1950 edition of the ASME Code and the 1951 edition of the API-ASME Code for Unfired Pressure Vessels. Principally affected have been the design equations for cylindrical shells and heads and some of the data relating to flange design.

A brief discussion of the principal materials of construction has been included. It gives the physical properties and fabricating characteristics of the different metals and has been written with special consideration of the needs of the designer of process equipment.

In general, it has been the intent, to give as concise a discussion as possible. For the reader who wants to make a deeper study of certain special

THE SPECIALIST ALWAYS KNOWS BEST!



Thermostatic charge confined inside bellows to operate switch, valve, etc. Bulb optional.

● If you use or need bellows assemblies, check with the specialists at Fulton Sylphon or Bridgeport Thermostat. Our more than half-a-century of experience in this specialized field can be a big help to you.

For one thing, we can take care of your bellows assemblies requirements quickly and accurately—help you save time, production problems and expense.

Or, if you require a specific type of assembly, our specialists will work with you to design and produce **exactly** what you need.

Sylphon and Bridgeport bellows assemblies are used to help solve many design problems involving control of temperature or pressure. Typical examples of their use are: as flexible connectors, for thermostatic devices, hydraulic mechanisms, expansion joints, pressure controls. Wide range of metals and sizes.

Write for helpful advice on your bellows assemblies needs or problems. And for ideas, ask for Catalog GP-1400.

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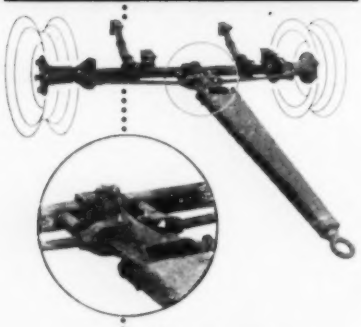
CARAVAN AXLES



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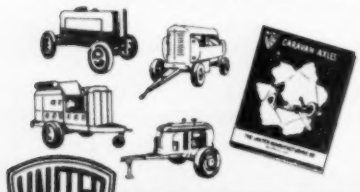

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problems, the extensive bibliography will be a convenient guide. It is hoped that this manual will become a useful reference book for the designer, process engineer and chemist.

The chapters are headed:

1. Selection of Materials
2. Iron and Steel
3. Copper, Brasses and Bronzes
4. Aluminum and Aluminum Alloys
5. Nickel and Nickel Alloys
6. Cylindrical Vessels under Internal Pressure
7. Cylindrical Vessels under External Pressure
8. Heat Stresses in Shells
9. Shell Thickness in Open Tanks
10. Disked Heads and Spheres
11. Flat Heads and Cover Plates
12. Reinforcement of Openings
13. Flange Design
14. Riveted Joints
15. Fusion-welded Joints
16. Copper Vessels
17. Everdur Vessels
18. Aluminum Vessels
19. Monel and Nickel Vessels
20. Stainless Steel Vessels
21. Vessels of Alloy-Clad Steel
22. Shell Stresses Due to Dead and Wind Load
23. Supports

Appendix—

Mathematical Engineering Analysis

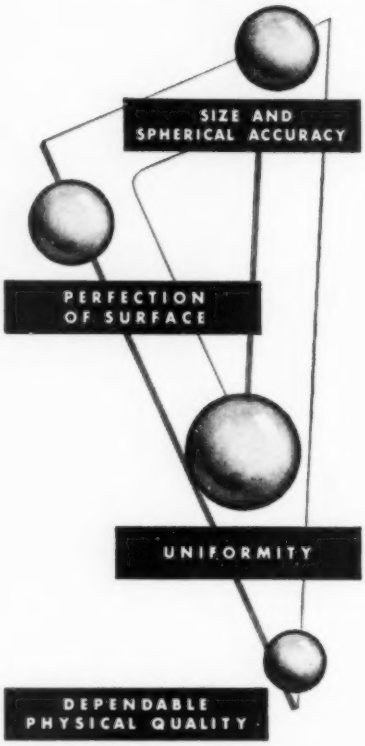
RUFUS OLDENBURGER, *Ph.D., Woodward Governor Co., 6 x 9 in., 426 pp. Published by the MacMillan Co., 60 Fifth Ave., New York 11, N. Y., $6.*

Written as a college text for engineering analysis courses and as a reference for the industrial researchman, the author's work covers the basic physical engineering problems confronting research men today.

It is divided into five parts dealing with mechanics of rigid bodies, electricity, and magnetism, heat, elasticity, and fluid mechanics. Fundamental theories are developed in order that the student can apply the principles to such problems as heat transfer, thermodynamics, vibration, dimensional analysis, velocity position, inertia forces, transistor applications, aerodynamic flow, and many others.

The underlying purpose of the text is to permit the application of a minimum number of engineering laws to physical problems with the facility of expressing those problems in mathematical form. Practical basis for the translation into mathematics is the use

from any angle



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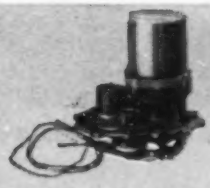

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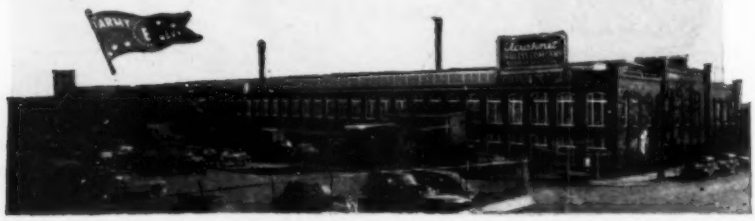


Address all communications to 768 Belleville Ave., New Bedford, Mass.

of such equations to experimentally evaluate engineering problems prior to spending further costly and time-consuming investigation efforts in the research laboratory.

Liberal use is made of explanatory problems in order that the student can test his understanding of the principles involved and his concept of the use of fundamental engineering laws to express physical problems. Setting up of the mathematical relationships is the primary result intended by the author. Solution of the problem-expressed equations is not required.

Information contained in the book is derived from mathematical-experimental investigations which are built upon a practical base so that the engineer can employ the simplifying techniques with confidence.

Standards for Steam Surface Condensers

8 x 11 *in.*, 17 *pp. Published by the Heat Exchange Institute*, 122 *East* 42 *St., New York* 17, *N. Y.*, $2.

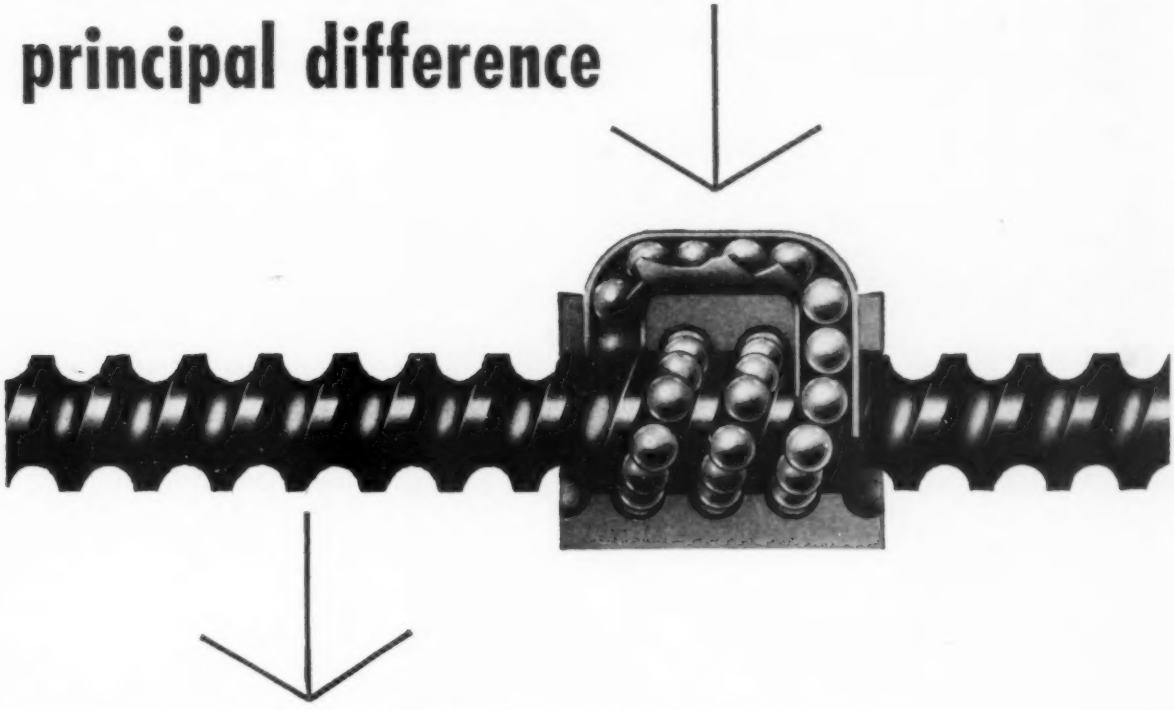
This was formerly a part of, and now supersedes the publication "Condenser Standards," Second Edition. It includes the latest standards data on the following factors: (1) Nomenclature and Definitions; (2) Condenser Performance; (3) Surface Condenser Sizes; (4) Vacuum Pump Capacity; and (5) Atmospheric Relief Valve Sizes.

Mechanics of Materials

SEIBERT FAIRMAN *and* CHESTER S. CUTSHALL, *Professors of Engineering Mechanics, Purdue University*, 6 x 9 *in.*, 420 *pp. Published by John Wiley & Sons, Inc.*, 440 *Fourth Ave., New York* 16, *N. Y.*, $5.75.

Aiming at the average college undergraduate with no previous work in this field, the authors present a sound discussion of the elements of mechanics of materials and provide means for a thorough training in the use of the basic principles. They have not attempted to produce a comprehensive treatise or one appropriate for superior students only. The text was designed to cover only that material which could be presented in about 64 class hours. The features of the book are: (1) Numerous illustrative examples, completely solved, to aid the student in learning how to apply the principles; (2) A more thorough explanation and illustration of the application of the area-moment method in connection

the principle makes the principal difference



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DIVISION, GENERAL MOTORS CORPORATION, SAGINAW, MICHIGAN

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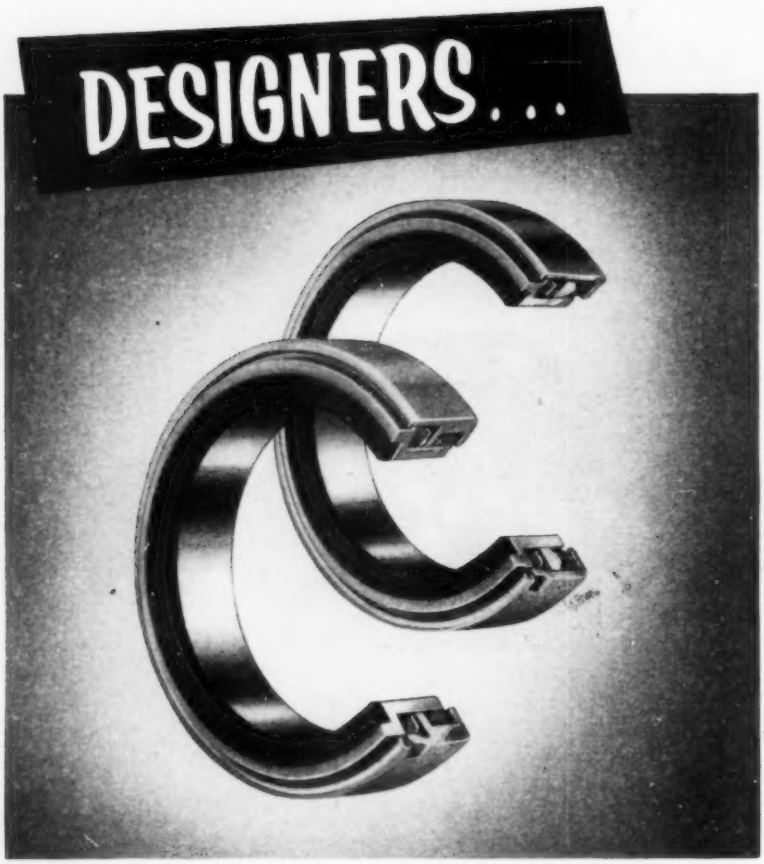

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with both statically determinate and statically indeterminate beams than is found in most books; (3) A more thorough and systematic treatment of combined stresses than is offered in most other books; (4) A treatment of columns designed to give a better understanding of the basic theory and its connection to the development of the empirical formulas used in practical design; (5) A large selection of problems to be solved by the student, over 700. Some of these are grouped at the ends of the specific articles on which they are based; the others are grouped at the ends of chapters and are often more general in nature or of a higher order of difficulty; (6) Elimination of certain advanced topics, included in many elementary books, which are primarily applications to some special field and are usually treated to better advantage in subsequent design courses—for example, structural connections, riveting of plate girders, shear flow, etc.

The Plastics Industry

BARRETT L. CRANDALL, *formerly Director of the Society of the Plastic Industry, New York, N. Y.*, 6 x 9 *in.*, 36 *pp. Published by Bellman Publishing Co., P. O. Box* 172, *Cambridge* 38, *Mass.*, $1.

A brief but informative summary of the following aspects of the plastics industry:

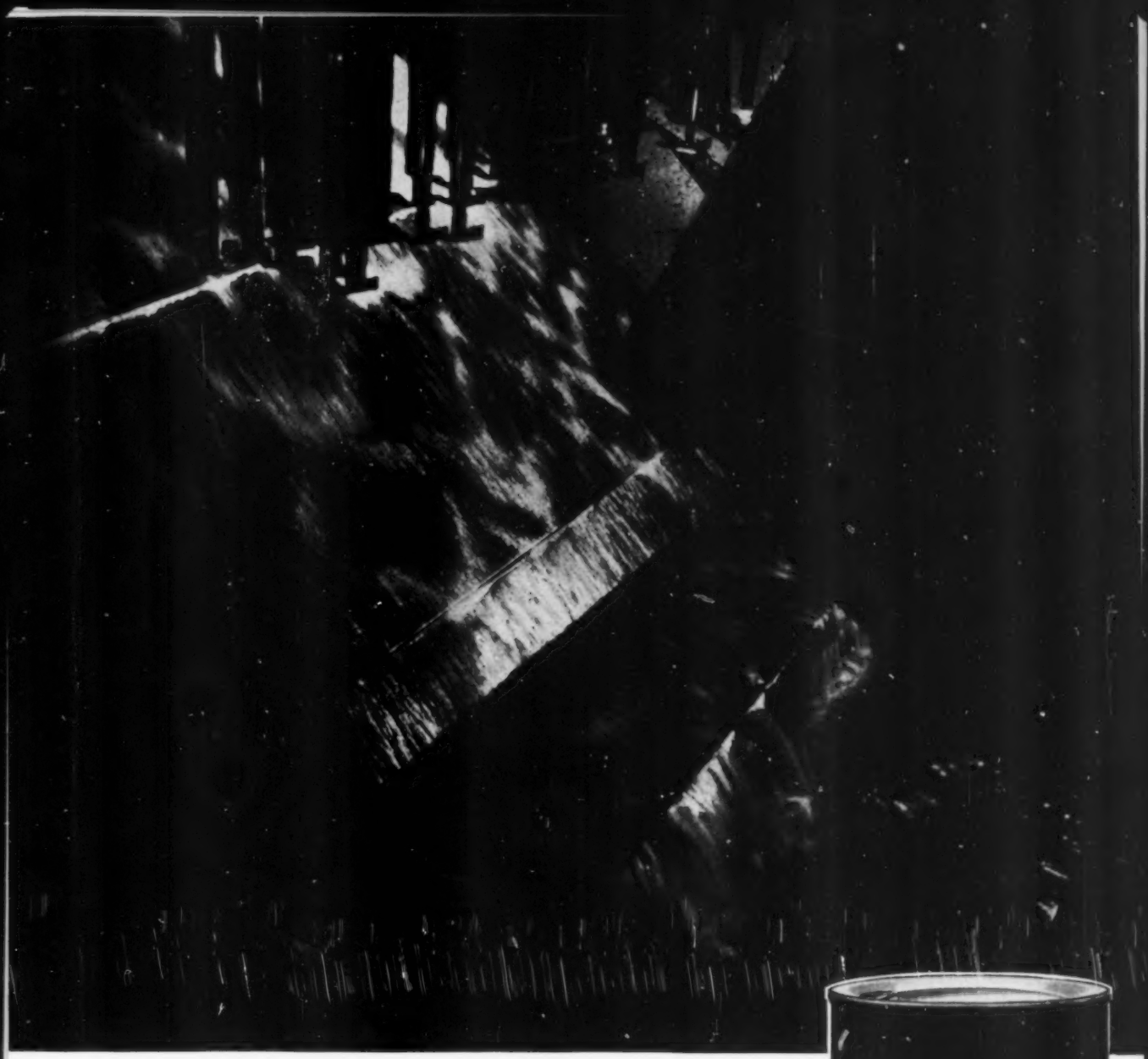
(1) Make-up of the Industry
(2) Methods, Forming and Fabrication of Plastics
(3) Description and Definitions of the Various Plastics Materials
(4) Personnel, Schools, Trade Associations and Trade Papers Associated with the Industry.

Physical Chemistry of Metals

L. S. DARKEN *and* R. W. GURRY, *Research Laboratory, U. S. Steel Corp.*, 6 x 9 *in.*, 535 *pp. Published by McGraw-Hill Book Co.*, 330 *West* 42 *St.*, *New York* 36, *N. Y.*, $8.50.

This book represents the fundamental aspects of physical chemistry, and the metallurgy of related substances to metallurgists with a minimum knowledge of general physical chemistry and to chemists with a minimum knowledge of metals.

The first section is devoted mainly to descriptions of the solid and liquid states of alloys and metals from the viewpoint of the chemist rather than that of the solid-state physicist. This is a comparatively new chemistry, where



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the species are atoms rather than molecules, and is therefore somewhat difficult to grasp because it is at variance with usual prior training. The atomic rather than the molecular structure of metals and alloys in the solid and liquid states is given a basic treatment.

The second section deals with classical chemical thermodynamics and the third law. The former is developed from first principles and related directly to metallic and metallurgical examples. The treatment differs from the average by the omission of nearly all treatment of nonideal gases (since nearly all gases behave ideally in metallurgical cases), and the brief treatment of aqueous solutions and solutions of organic substances. This permits, in a minimum of space, the inclusion of a more extensive treatment of pressure-temperature-composition relations in heterogeneous systems where several phases may be of variable composition, for these phases are the rule rather than the exception in metallic systems.

There is a final section on rate phenomena, particularly diffusion, with emphasis upon applications to metallurgical substances.

Complex Analysis

LARS V. AHLFORS, *Professor of Mathematics, Harvard University*, 6 x 9 *in.*, 247 *pp. Published by the McGraw-Hill Book Co.*, 330 *W.* 42 *St., New York* 36, *N. Y.*, $5.

A first year graduate text, this volume covers the elementary portion of the theory of functions of one complex variable. Designed primarily for the M.S. and Ph.D. student of mathematics as a foundation for further specialization, it also provides the complete coverage and understanding necessary to the mathematician specializing in another branch of the subject, to the theoretical physicist, and to the theoretical engineer.

Decidedly serious in mathematical treatment, the text is rigorous while at the same time remaining fundamental and, therefore, not unduly difficult. With the emphasis placed upon a true understanding of the entire structure of the material covered, the reader who has mastered the text will be able to actually understand the use of complex analysis in physics and related fields, as well as being extremely well equipped for further study of complex function theory. Concerned primarily with the pure theory of the subject, few direct applications are discussed.

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book is the manner of treatment of topology as an integral and essential part of analysis. Because the author wishes to inculcate the geometric method of thought in the reader and guard the student against the fallacious view that the integral is a cure-all which can be employed automatically without a deeper understanding, he introduces the complex integral relatively late in the text.

This text is the first to make use of Artim's treatment of Cauchy's theorem. It also covers Perron's method, a subject seldom treated in books of this kind. Comprehensive and stimulating exercises have been incorporated into the body of the text as an aid to student understanding.

The author is one of the foremost representatives of the famous Finnish school of complex function theory and is renowned for his work, lectures, and articles in the field.

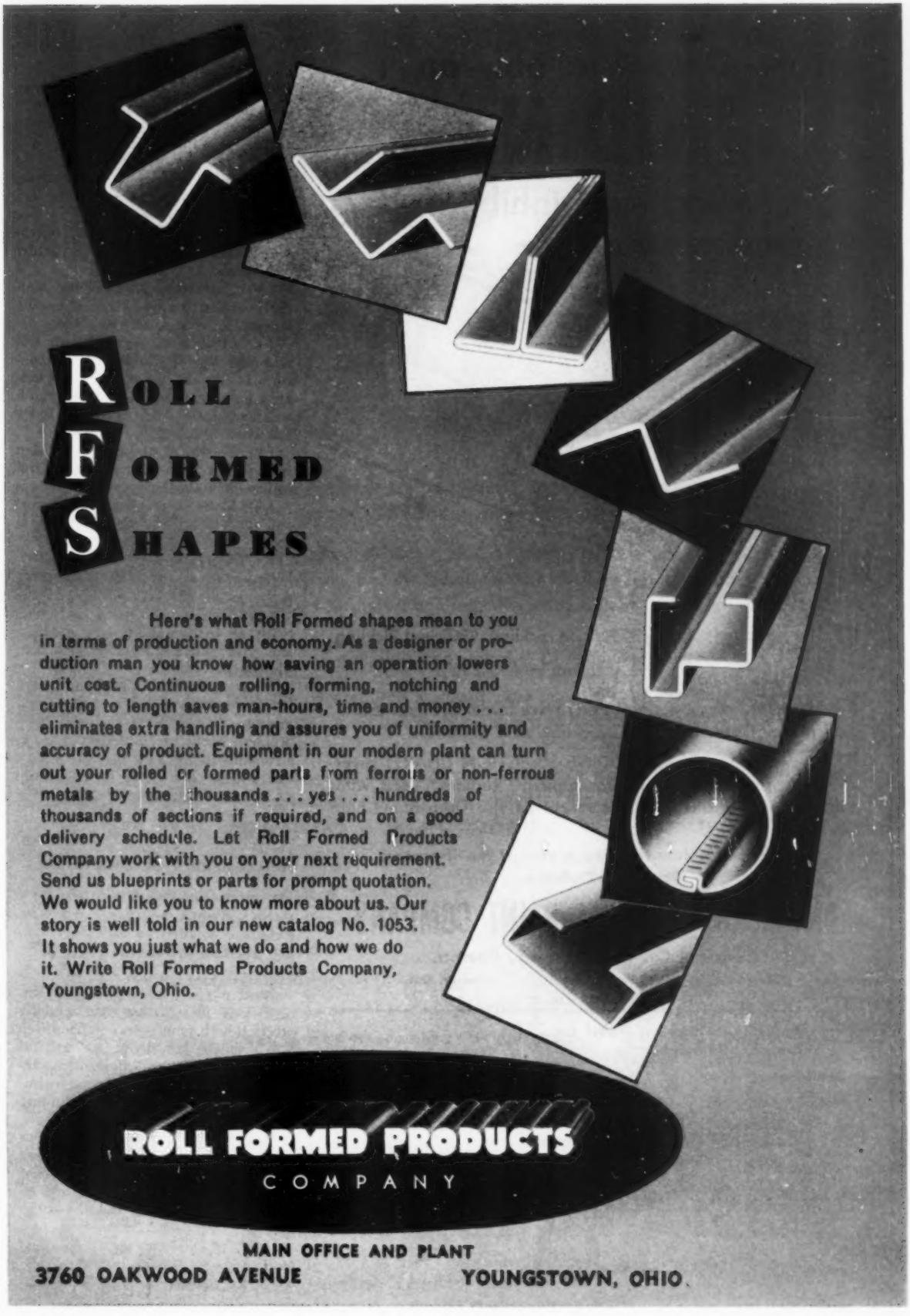
Engineering Drawing

THOMAS E. FRENCH, *Late Professor of Engineering Drawing, Ohio State University, and* CHARLES J. VIERCK, *Professor of Engineering Drawing, Ohio State University.* 6 x 9 *in,* 715 *pp. Published by McGraw-Hill Book Co.,* 330 *W. 42nd St., New York* 36, *N. Y.,* $6.

This new edition brings the text and problems up to date by eliminating obsolete material and incorporating the practices and techniques consistent with current standards. The book is completely revised and is now arranged to follow a logical pattern of engineering drawing development.

The basic plan has been to make the book a better text for colleges and a more useful reference for the engineer's technical library. In this new edition, material is now arranged in four basic divisions: First, the basic material on shape description—including pictorial sketching, perspective, intersections, and developments. Second, the chapters on size description, including the relationship between the drawing and the shop, and also the advanced material on precision and limit dimensioning. Third, the basic machine elements, screw threads, fasteners, keys, rivets, springs, gears and cams, etc. Fourth, the chapter on working drawings, followed by architectural, structural, map and topographic drawing, etc. Almost every chapter has been revised to make the material easier to understand, easier to teach, and easier to use.

In general, new material has been



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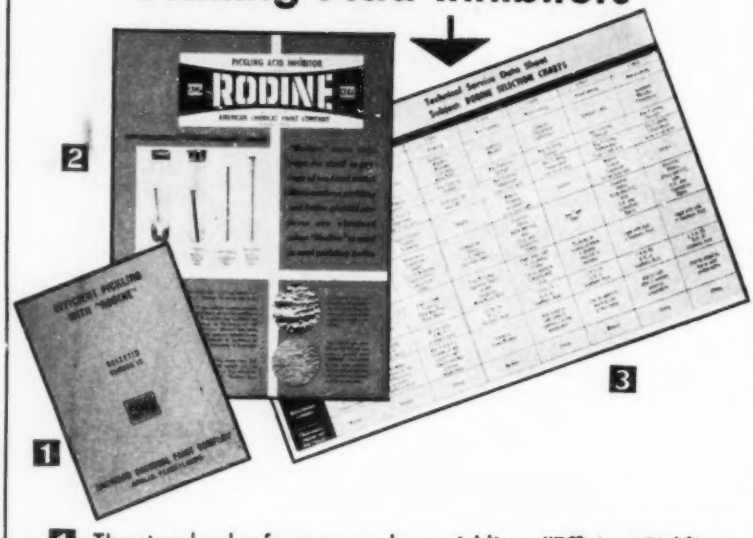

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added wherever necessary for improvement. Effort has been made to have the basic material taught by a majority of users as complete as possible within reasonable limits of length.

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(4) Material on screw threads and fasteners has been rewritten to conform to the new unified thread standards, new Acme and stub Acme standards, and new ASA bolt and screw standards.

(5) Treatment of keys, rivets, and springs has been contemporized and follows new standards and practices.

(6) Material on welding is new and conforms to the new ASA Standard.

(7) Working sketches have been included in the section on working drawings.

(8) Architectural material is virtually all new, and the new modular and grid systems are explained and illustrated.

Many new illustrations and problems have been added to replace and improve on the older editions. Two problem books are available. One is a combination of 8½ x 11 and 11 x 17 size sheets. The other includes only 8½ x 11 size sheets.

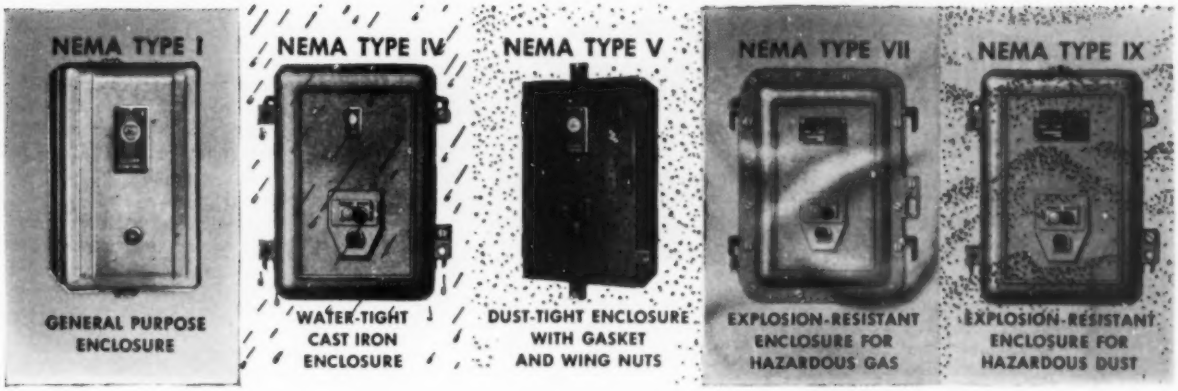
Aerodynamics of Propulsion

DIETRICH KUECHEMANN *and* JOHANNA WEBER. 340 *pages*, 6 x 9 *in. Published by McGraw-Hill Book Co., 330 W. 42 St., New York 36, N. Y.*, $9.

Written for the designer and student, this presentation is essentially practical with some theory in handling. No detailed knowledge of general aerodynamics or of higher mathematics, other than differential calculus, is necessary for an understanding of the material.

Major types of propulsion systems are reviewed. Particularly interesting and new is a detailed discussion of the aerodynamic aspects of the ducted airscrew, the ram jet, and the turbo jet.

Here in one volume, is collected much material previously unpublished or widely scattered. The topics include engine fairing, air intakes, jet-



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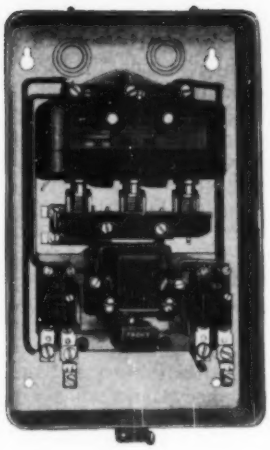

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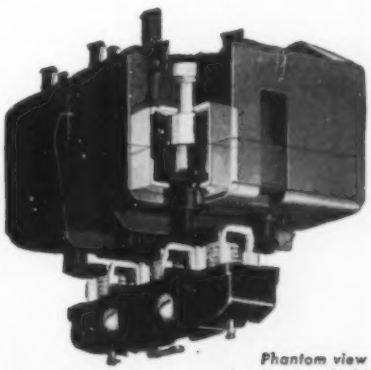

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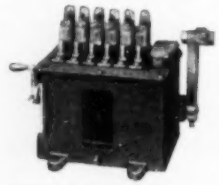

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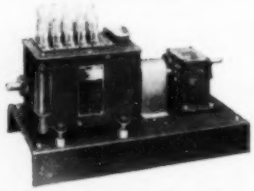

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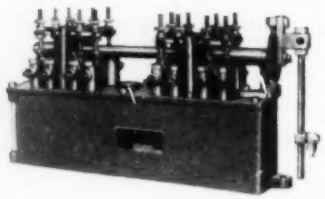

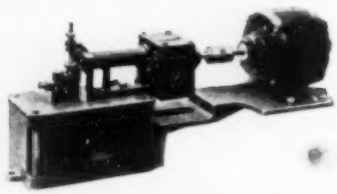

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Physical Chemistry For Colleges

E. B. MILLARD, *Professor of Physical Chemistry, Mass. Institute of Technology, 6 x 9 in., 618 pp. Published by McGraw-Hill Book Co., 330 West 42 St., New York 36, N. Y., $6.*

A general revision of a popular text, this seventh edition breaks down into terms of simple accuracy the high complexity of physical chemistry and brings this subject within the grasp and understanding of the qualified student with a background of chemistry, physics, and calculus. It covers all important topics of the fields such as elementary thermodynamics, laws applicable to gases, liquids, crystals, solutions, electrolytes, homogeneous equilibrium, heterogeneous equilibrium, phase diagrams, reaction kinetics, and applications of free-energy potentials.

One of the major changes is the treatment of thermochemistry and the first law of thermodynamics which are now placed directly after the introductory chapter on thermodynamics. This provides the student with a longer, more thorough contact with the subject rather than breaking the presentation into separate parts; hence the student will more easily gain a clearer understanding.

The text has been generally revised and rewritten for greater clarity in expression as well as to bring it up to date. New illustrative material has been added to both text and problems, which brings a fresh approach and provides at the same time more accurate and complete illustration of principles. There has been a revision and amplification of the problem lists throughout the text with the addition of more advanced problems. Furthermore, the lists have been divided to separate the more mature problems into a second section. Order of topics within each of these groups, however, is still the order of presentation in the text. A feature of the volume is the scope and variety of these problems, which all have a firm basis on actual experimental data.

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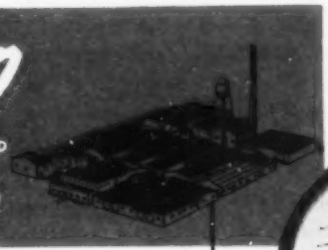

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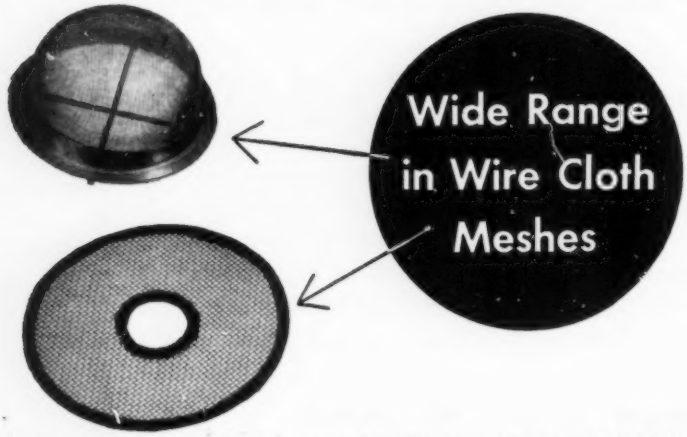

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A BIG PUSH IS ON to streamline industrial drafting. General Electric Company is encouraging their more than 5,000 draftsmen to strip the frills from their drawings. But draftsmen are being cautioned that the use of short cuts or abbreviated methods is not a license for careless, sloppy work.

Apparently GE's drafting organization became so engrossed with product design and development that drafting practices fell far behind the general trend of industrial progress. The current industrial manpower shortage brought this situation to a head. Casting around for more draftsmen, a good look was taken at accepted drafting procedures. What was found was that planning, production and manufacturing people are not interested in fancy drafting techniques nor beautifully executed time-consuming layouts. Wanted is complete, concise and accurate information at the proper time.

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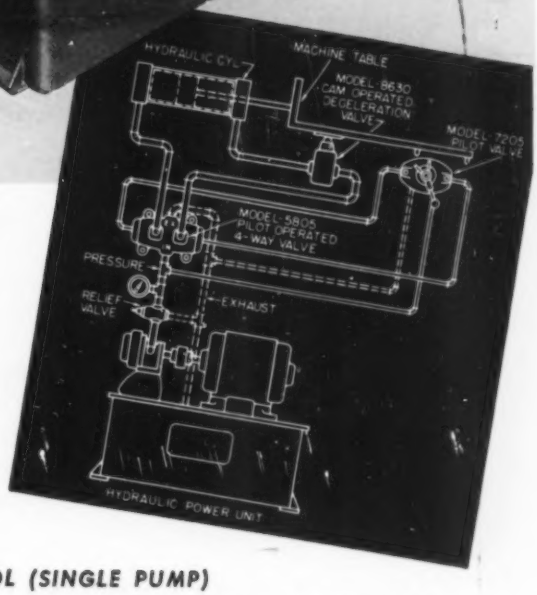

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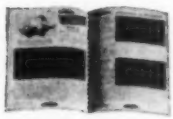

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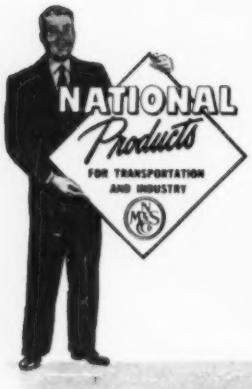
RIVETT LATHE & GRINDER INC. • Brighton 35, Boston, Mass.
Department PE-4

WHEN YOU APPLY HYDRAULIC OR AIR POWER *Plan with* **RIVETT**

AIR AND HYDRAULIC VALVES AND CYLINDERS, HYDRAULIC POWER UNITS

Castings by National

selected for Quality and Dependability



Products bearing these familiar trademarks have all established enviable reputations for quality and dependability.
These manufacturers *continue* to procure castings by National—one of the Nation's largest founders.

National's unparalleled experience in producing malleable, heat-treated malleable, and steel castings is at your disposal. Sales offices and engineering facilities are located at all five strategically located plants. A-5346

PLANTS LOCATED IN Sharon, Pa., Cleveland 6, Ohio, Indianapolis 6, Ind., Melrose Park, Ill., and Chicago 50, Ill.

A 16mm technicolor film. Narrated by Edwin C. Hill, this 27-minute film tells how malleable iron is made . . . tested . . . used . . . how its production economy, ductility, machinability, toughness will give you a better finished product. Available for group showings.

NATIONAL
Products
FOR TRANSPORTATION AND INDUSTRY

NATIONAL MALLEABLE and STEEL CASTINGS COMPANY
CLEVELAND 6, OHIO
Est. 1868

in selling the program was to point out three easy and effective practices that could be applied immediately to reduce time and effort.

1. Simplification of the drawing or sketch.
2. Elimination of non-essentials.
3. Extensive use of free-hand drawing.

Draftsmen are urged to eliminate those things which add nothing to accuracy, completeness or clarity. Examples of work that never should be done: extra views, unnecessary elaboration, superfluous lines, repetition, use of conventional representation instead of symbolism. Stress is placed on the use of free-hand drawing. When used judiciously, it is both practical and economical. And all conditions being equal, up to 30 percent of the average draftman's time can be saved by use of this practice.

The entire program is keyed to one thought—the really important part of a draftman's job is thinking, not picture making. Less time spent on the actual making of the drawing leaves more time for the real productive effort of creative thinking.

Graphic Tool Pin-Points Production Lags

GRAPHIC PRODUCTION ANALYSIS, an effective tool of the U. S. Navy during World War II, is again being used to show up production weaknesses in aircraft, amphibious tank and other arms programs. Production status is analyzed and potential production bottlenecks are quickly earmarked for corrective action.

Office of Naval Material says the analysis has four basic uses. It isolates and identifies early in the production cycle items in short supply. It isolates government supplied items in excess of production requirements. It increases the accuracy of delivery estimates. It checks the contractor's performance, the status of government furnished material allocations, and serves as a basis for terminating production.

How system works: five-man teams go into the plants and meet with all plant executives involved in production matters explaining purpose and procedure of analysis.

The team then fans out through the factory and collects data on assembly line layout and content, processes, lead

Get DOT® to do it!

Turn your special fastening problems over to United-Carr and free your own design staff for full-time work on finished-product engineering.

United-Carr's engineering department is constantly at work, improving current DOT fasteners and designing entirely new fasteners to meet the changing needs of industry.

Experience gained through working with the leading manufacturers of automobiles, aircraft, appliances and furniture as well as electronic apparatus . . . enables us to bring an unusually wide variety of abilities and techniques to bear on your particular fastening problems. And, with complete facilities for volume production of metal fasteners and the assembly of metal to plastic and ceramic components, we are in a position to supply practically any fastening need.

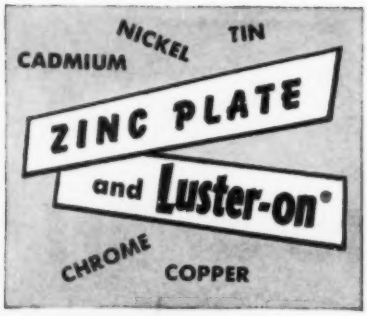
The fasteners and assemblies illustrated here are typical of thousands of special devices designed and manufactured by United-Carr and its subsidiaries.

We urge you to call in your nearest United-Carr field engineer before *your new designs crystallize. It is at this all-important planning stage that you can make most effective use of our special services.*

UNITED-CARR

MAKERS OF DOT FASTENERS

UNITED-CARR FASTENER CORPORATION, CAMBRIDGE 42, MASSACHUSETTS



Study ALL angles and

ONE FINISH STANDS OUT

Study METAL COST

ZINC is the cheapest metal to plate. Even with LUSTER-ON Passivating Dip added it still COSTS LESS than Cadmium, Copper, Nickel and Chrome or any other finish that we know of today.

Study TIME COST

Zinc plate with simple Luster-on cold dip treatment will usually SAVE 2/3 of the PROCESSING TIME of flash copper, nickel and chrome work. TIME COSTS YOU MONEY — SAVE IT WITH LUSTER-ON.

Study POWER COST

Zinc plate and Luster-on require no heavy power to plate or heat metals such as nickel and chrome. YOU SAVE ON POWER USED and RECTIFIER or GENERATOR EQUIPMENT REQUIRED.

Study THE FINISH

Zinc and Luster-on, applied manually or in full automatics, can nowadays show finishes so beautiful, so gleaming that they bow to no one. Proved again and again superior to cadmium for most purposes, they rival traditional chrome.

Study ALL ANGLES

You'll soon see why big companies and job shops alike agree that Zinc and Luster-on is here to stay — has established itself over the years, not just as a substitute for scarce metals. BUT BE SURE THE PASSIVATING DIP YOU USE IS GENUINE Luster-on — "The first in the field and still the leader."

Write for free data sheets and send a part for free processing.

THE Chemical CORPORATION

59 Waltham Ave., Springfield 9, Mass.

times, and stock positions and quantities of purchased, sub-contracted, plant manufactured and government furnished materials and assemblies.

After the data is correlated, essential facts of a plant's production status are shown on a single chart in three separate but interrelated diagrams. One diagram shows the planned, estimated and actual deliveries, another is a schematic of the main assembly line with lead times and assembly positions of selected materials and components superimposed, and the third diagram is a bar chart that shows the availability of materials and components which control the quantity and rate of production. Real value of system then lies in enabling management to take early preventive action.

Gallium Is Still A Metal of the Future

AT $1000 PER LB gallium continues to be a metallic "white elephant." According to Alcoa, it is one of the strangest performers in the metals family. At 86 F it melts, but doesn't boil until 3,600 F. Like water, it expands upon solidification. It shows marked differences in electrical resistivity and coefficient of thermal expansion along the direction of the three axes of its crystallographic structure. Gallium's electrical resistivity variability probably varies greater than for any other metal. Also, it emits electrons at extremely low temperatures.

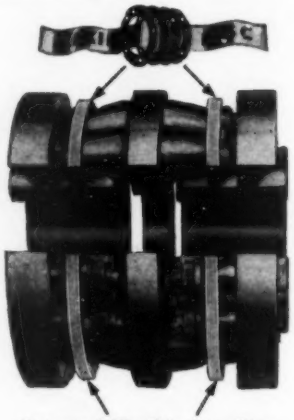
Uses to date: in dental alloys for gold restoration work, excitant for phosphors in fluorescent lighting and luminous paint, in selenium rectifiers, as a catalyst for polymerization of vinyl ethers, in diagnosis and treatment of bone cancer, and as liquid seal on inlet system of mass spectrometers. Net total lbs used—almost negligible.

Other applications attempted: high temperature liquid thermometer, manometer liquid, low melting alloy.

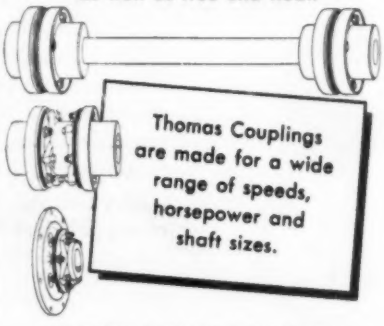
WORLD'S LONGEST RUBBER CONVEYOR BELT is operating at U. S. Steel's Fairless Works hauling 250 F coke, weighing 30 lbs per ft on the belt, at 300 ft/min. Capacity rate for Goodyear's 5,500 ft long conveyor is 400 tons per hour. Belt is four ft wide and constructed of compounded synthetic rubber and rayon fabric.

Specify THOMAS ALL METAL
FLEXIBLE COUPLINGS
for Power Transmission to avoid Costly Shut-Downs

DISTINCTIVE ADVANTAGES	
FACTS	EXPLANATION
NO MAINTENANCE	Requires No Attention. Visual Inspection While Operating.
NO LUBRICATION	No Wearing Parts. Freedom from Shut-downs.
NO BACKLASH	No Loose Parts. All Parts Solidly Bolted.
CAN NOT "CREATE" THRUST	Free End Float under Load and Misalignment. No Rubbing Action to cause Axial Movement.
PERMANENT TORSIONAL CHARACTERISTICS	Drives Like a Solid Coupling. Elastic Constant Does Not Change. Original Balance is Maintained.



Patented Flexible Disc Rings of special steel transmit the power and provide for parallel and angular misalignment as well as free end float.



Thomas Couplings are made for a wide range of speeds, horsepower and shaft sizes.

THE THOMAS PRINCIPLE GUARANTEES PERFECT BALANCE UNDER ALL CONDITIONS OF MISALIGNMENT

NO MAINTENANCE PROBLEMS

ALL PARTS ARE SOLIDLY BOLTED TOGETHER

Write for our new Engineering Catalog No. 51

THOMAS FLEXIBLE COUPLING CO.
WARREN, PENNSYLVANIA, U.S.A.

For the Production Engineer's Notebook—

Ideas for Welded Design

Product engineers, even the geniuses among them, find that the formula, "1% inspiration, 99% perspiration,"* pretty regularly applies.

Perspiration in design is brought about by the inevitable conflict between operating function—how well the part will do its job—and such other important factors as sales appeal, serviceability, and manufacturing methods.

What we are all striving for is to apply welding most economically. We in LINDE stand ready to help the product engineer in the applications of welding methods wherever we can. Sometimes economies in production come from a substitution of welding for more expensive methods, but often just a small change in design or practice reduces the cost of present welding operations.

Pointers on welded design leading to production economies.

Use the process that gives the greatest total economy.

Design for down-hand welding where possible. But locate welds so as to minimize handling.

Mechanize welding. Weld as many joints simultaneously as possible.

Make minimum dimension changes when making different sized models.

Reduce the number of parts. But sometimes it is better to increase the number of parts and cut rejects in intricate castings or formings by welding together simple forms.

Use standard shapes and easily formed sections.

Pointers on welding processes leading to production economies.

HELIARC welding: used for most metals—argon protects weld puddle. Minimizes cleaning and finishing costs. Manual, mechanized, and semiautomatic welding. Latter ideal for work on sheet materials with irregular contour.

Sigma welding: consumable electrode supplied as continuous coil of wire. Makes clean, smooth welds in practically all commercial metals at high rates of deposition, low costs, and high weld zone cooling rates.

UNIONMELT welding: high speed process for making deep-penetrated welds—butt, tee, lap fillets, plug—in most ferrous and non-ferrous metals. Usually mechanized, but also applicable by hand with flexible welder.

Take advantage of other economies that are inherent in such oxy-acetylene processes as flame-cutting, welding, surfacing, hardening. For more information on any of these processes call or write the nearest LINDE office today.

* "Genius is 1% inspiration and 99% perspiration," credited in GOLDEN BOOK, April, 1931, to a newspaper interview with Thomas A. Edison.

LINDE AIR PRODUCTS COMPANY
A Division of Union Carbide and Carbon Corporation
30 E. 42nd St., New York 17, N. Y. UCC Offices in Other Principal Cities
In Canada: DOMINION OXYGEN COMPANY, LIMITED, Toronto
The terms "Heliarc" and "Unionmelt" are registered trade-marks.

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CHANGE GEARS

MITRES — BEVEL GEARS

HELICALS
WORMS and WORM GEARS

CHAIN and
SPROCKET

BOSTON GEAR CATALOG

Lists all gears and other BOSTON Products. Contains time-saving information on gear selection and useful reference data. Ask your Boston Gear Distributor . . . . or write: Boston Gear Works, 71 Hayward Street, Quincy 71, Mass.

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and
FLANGED CARTRIDGES

UNIVERSAL JOINTS

COUPLINGS

Put this **STAMP OF APPROVAL** of 250,000 users on your product.

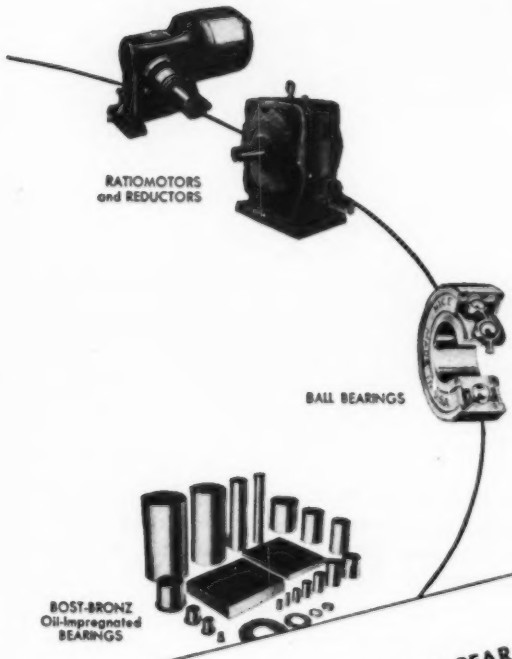
EQUIPPED WITH BOSTON gear® Standardized Products

BOSTON gear®

STANDARD STOCK GEARS

and other

POWER TRANSMISSION EQUIPMENT



At Authorized BOSTON GEAR DISTRIBUTORS — a

$10,000,000

stock of BOSTON Gears and other BOSTON Products is ready to fill your orders promptly

for LOWER COST

Compare your gear-cutting costs with cost of precision-made, completely interchangeable BOSTON Standard Stock Gears. You'll find it pays to design around BOSTON.

for WIDEST SELECTION

The BOSTON Catalog lists over 2000 types and sizes of gears . . . and a full range in the many other BOSTON Power Transmission Products.

for PROVED QUALITY

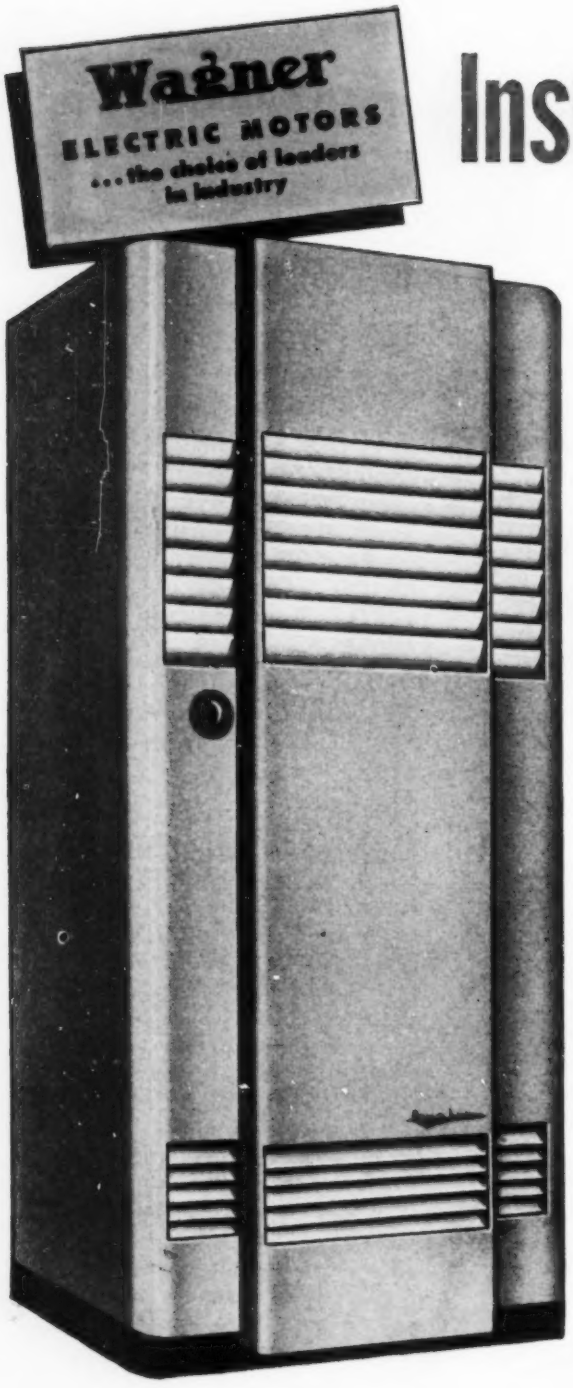
There's no "gamble" when you add BOSTON to your purchasing specifications. BOSTON quality has remained the industry's standard for 75 years. That's why BOSTON products are first choice of more than 250,000 cost-wise industrial buyers.

for NEARBY STOCKS

These BOSTON Products are available from 80 of the nation's top-rated, most experienced Industrial Distributors. When it's BOSTON equipped, the machine you make is only minutes away from a reliable source of repair parts.

GET THE "BEST BUY" . . . GET IT FASTER

Let **BOSTON** be your "buy-word"



Insure your sealed use

Wagner Hermetic Motor of the type used in self-contained air conditioners. This 7½ horsepower polyphase squirrel-cage motor is especially designed for use in sealed refrigeration units.

This compact, self-contained air conditioning unit, that may be located in or out of the air conditioned space, is typical of many such units powered by Wagner Hermetic Motors.

Wagner Electric Corporation
EST. 1891

WAGNER ELECTRIC CORPORATION
6406 Plymouth Avenue • St. Louis 14, Mo., U. S. A.

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

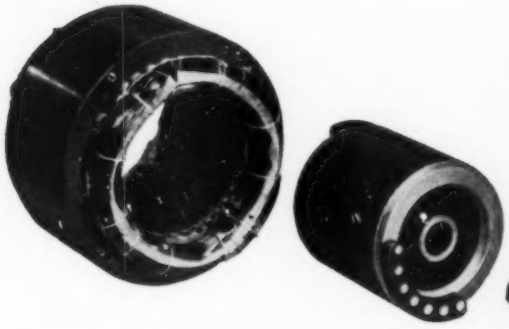
units against motor failure...

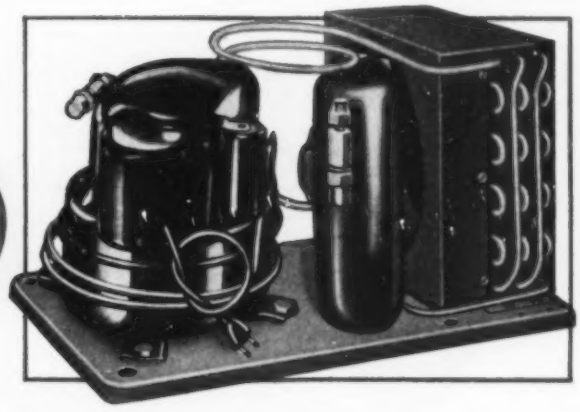
Wagner Hermetic Motors

Hermetically sealed compressors for air conditioners and refrigerating equipment are rapidly gaining preference because of the great convenience they offer to users of the equipment—there is nothing to oil or adjust, no belts to wear out.

Wagner can provide hermetic motors to power *your* equipment. Wagner hermetic motors are available for both polyphase and single-phase applications. These hermetic motors, like all Wagner Motors, are backed by more than sixty years of motor building experience. Each Wagner hermetic motor is precision-built and carefully tested.

Consult a Wagner engineer on your motor applications. Call the nearest of our 32 branch offices, or write us for full information.





This ¾ hp single-phase, capacitor-start Wagner Hermetic Motor is the type used in hermetically-sealed refrigerating units like the one shown at right.

it's to your advantage to standardize with Wagner

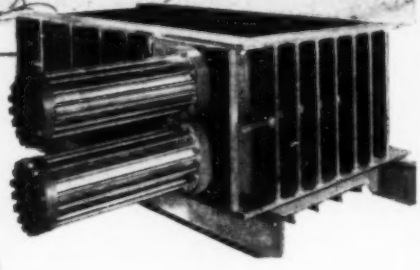
Wagner Motors are the choice of many leading equipment manufacturers for several basic reasons:

First, Wagner Motors, for over sixty years, have established unexcelled records for continuous, trouble-free performance.

Second, Wagner Motors are well known for their superior quality and their sturdy design and construction.

Third, the many types of motors and motor modifications in the standard Wagner line help the designing engineer in his selection of the right motor for the job.

M53-2



D & J PRESS CO. LINES THEIR BALING PRESSES WITH SPEED TREAT STEEL PLATE TO STAND THE GAFF!

D & J Press Co., Inc., Buffalo, N. Y., builds scrap baling presses large enough to take an automobile and compress it into a bale 2' x 2' x 5', weighing about 1-ton. The charging box is 6' wide, 5' deep, 14' long. Compression, from one end and one side, is furnished by two 14", 2,000 lb. cylinders and two 17", 2,000 lb. cylinders. Construction is welded heavy boiler plate. Charging box and platens are lined with ¾" SPEED TREAT (X1545) open hearth, medium carbon steel plate — selected because it is so easy to machine (in this case, drilling holes), and because it ably resists abrasion and impact. In this application the SPEED TREAT plate has a tendency to work-harden and resists gouging.

SPEED TREAT Steel, one of the Speed Steels, has remarkable physical properties — speeds machining, increases tool life, readily polishes to a high lustre, suited to flame or induction hardening and other treatment — widely used for machine parts, hardened gears and sprockets, rubber molds, short run blanking dies, etc. Consult your nearest distributor.

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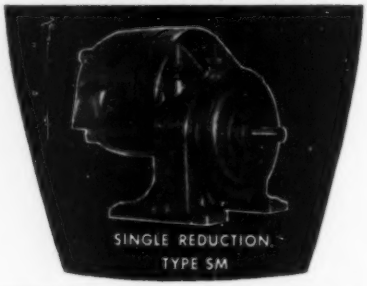
Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

RUGGED RELIABLE *Gearmotors*

DOUBLE REDUCTION, TYPE RM



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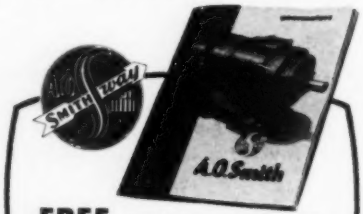
THESE Industrial Gearmotors are built to stand up under all conditions. Here's why – quality construction throughout, finest alloys for gears and pinions, accurate alignment, heavy-series ball bearings, rigid cast iron frames and precision production.

A. O. Smith Gearmotors are offered in twenty-one standard speeds ranging from 780 RPM down to 13.5 RPM and in ratings from 1 HP to 50 HP. Standard AGMA Classes I, II and III. Special output speeds and mounting arrangements available on request.



FREE – For 12-page engineering bulletin, write A. O. Smith Corporation, Electric Motor Division, 1000 Webster St., Dayton 4, Ohio. Or, Western Division, 5715 SMITHway St., Los Angeles 22, Calif.

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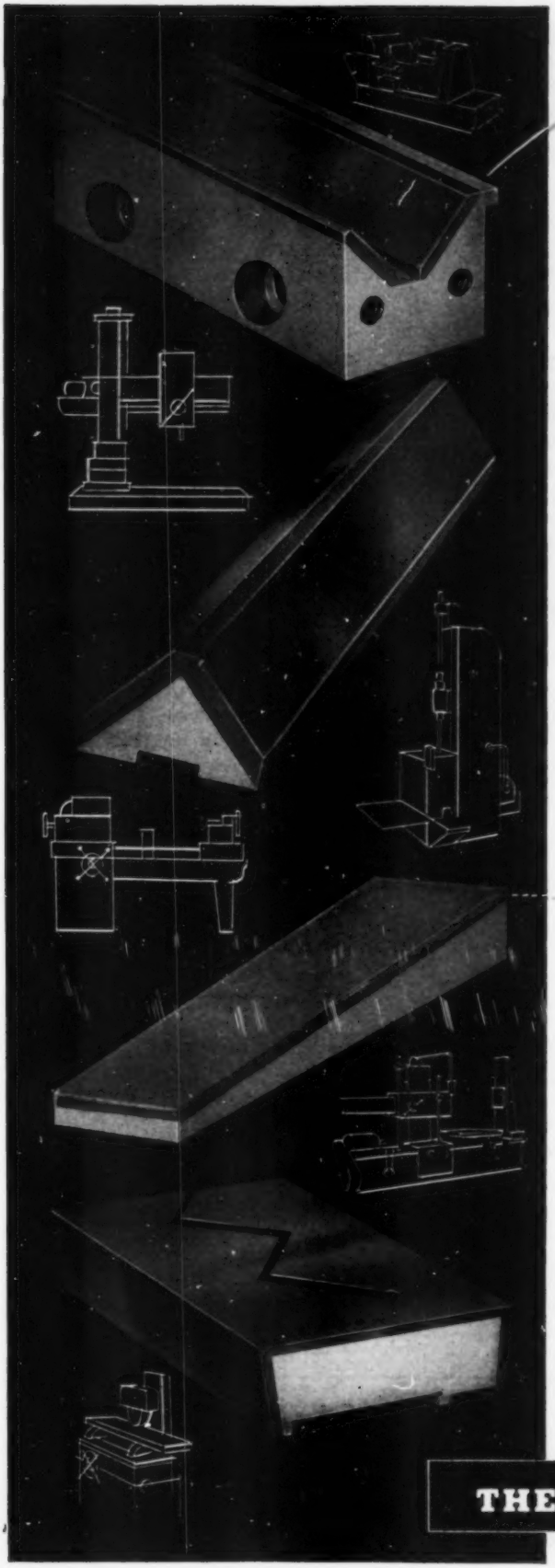

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let'em go with OK hardened ways, gibs, ball races, and Ampco* bronze wear strips

The ultimate success and accurate life of your machine depends to a large extent on the accuracy, and uniform high hardness of its ways, gibs, ball races or wear strips. OK parts are the finest. They are made of special tool steel welded to a backing of soft tough steel under 2500 tons pressure, then hardened to a Rockwell C-65-66 and ground to tolerances of ± .00015 (both straight and parallel). They are available in all sizes and shapes, to meet your particular requirements.

OK wear strips are now available in welded Ampco bronze. Because of the OK's special bi-metal method of welding, less bronze is required. These ways are ground to close tolerances thus reducing manufacturing and assembly time.

Mail coupon below for comprehensive bulletins.

Manufacturers for the Metal Working Industry of Slitter Knives, Shear Blades, Rotary Shear Knives, Hardened Spacers, Hardened Ways, Gibs, Ball Races, Bronze Ways, and Wear Strips.

*Reg. U. S. Pat. Office by Ampco Metal Inc.

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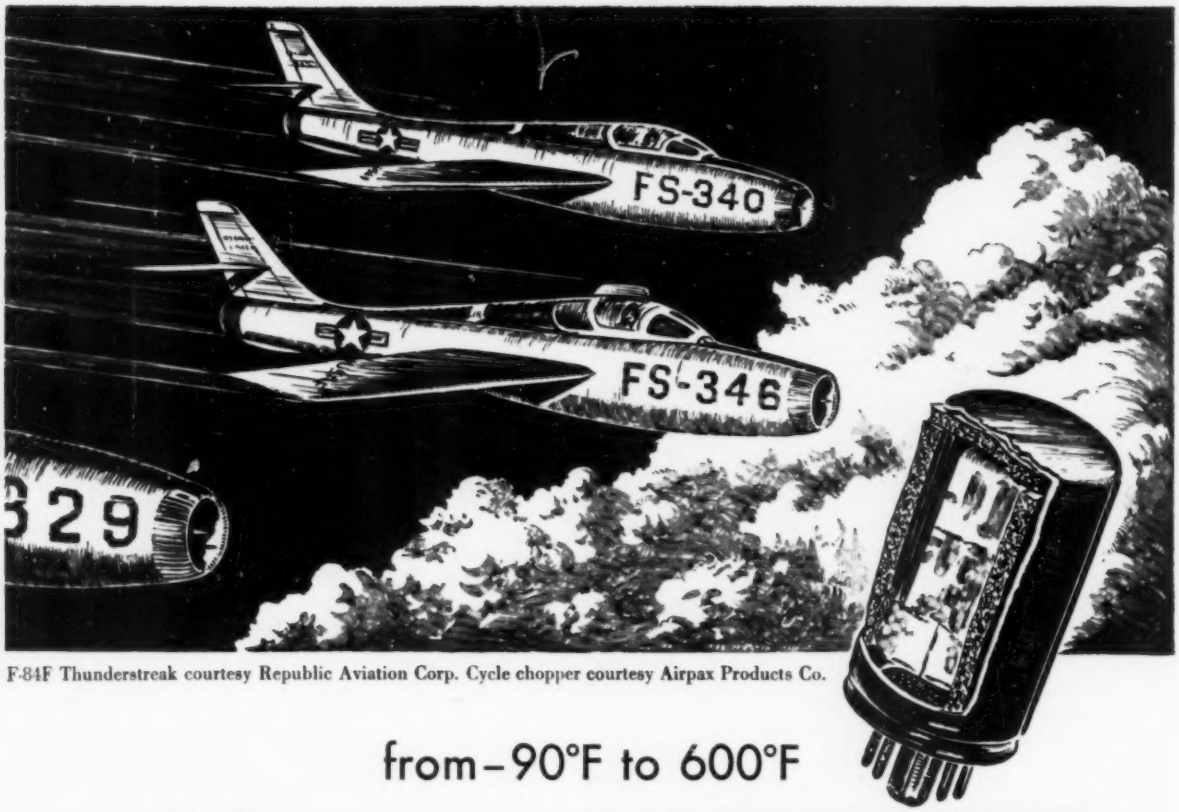

F-84F Thunderstreak courtesy Republic Aviation Corp. Cycle chopper courtesy Airpax Products Co.

from −90°F to 600°F

SPONGEX CELLULAR SILICONE RUBBER

effectively dampens vibrations

For their cycle chopper, widely used in aircraft, Airpax Products needs a special type of cushioning material—one that dampens vibrations at wide extremes of temperature.

The material that meets both requirements is Spongex cellular silicone rubber. Cellular rubber absorbs the shock; silicone provides thermal stability.

This double performance value is further enhanced by the lower cost of Spongex cellular silicone rubber. Compared to mechanical silicone, Spongex cellular silicone rubber often cuts costs 50% or more.

Check your use of silicone rubber—perhaps, your product will give better service or be produced at less cost with Spongex cellular silicone rubber. Write to us for further information.

Spongex cellular silicone rubber is available in cord, tubing, strips, slabs, die cut shapes and molded forms.

SPONGEX® Cellular Silicone Rubber

used under extremes of temperature conditions for cushioning, insulating, shock absorption, sound and vibration damping, gasketing, sealing, weatherstripping and dust proofing.

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SHAKEPROOF® THREAD-CUTTING SCREWS

Save time... Save tools... Give you a tighter, stronger fastening!

The shank slot does it! Type 1 is designed for the harder metals. Type 23 with a wider slot works well in die castings. Type 25 with a spaced thread is ideal for plastics.

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America's Great Resources Plus A Free Economy Made This Business Possible!

FREE...TESTING SAMPLE KIT

. . . contains SHAKEPROOF Thread Cutting Screws in a variety of sizes and head styles. Try them on your product now . . . ask for Kit No. 22 for metals or Kit No. 10 for die castings or plastics.

Mill Roll Manufacturer Reports

PRODUCTION BENEFITS

resulting from high

UNIFORMITY

of Standard rings

By exercising precise control of forging and rolling operations, the Standard Steel Works Division assures greater *uniformity* in the structure and analysis of each ring.

Typical of performance records is a report from a large eastern manufacturer of mill rolls where Standard rings are employed as thrust rings (inside bearing raceways) on the finished roll. Not only do they report a 50% saving in cost, but they also find that the grain structure, analysis and precise specification of the steels used in Standard Steel weldless rings is of the highest caliber.

Thus another reason why you should standardize on Standard Steel rings and flanges to protect the quality of your products is the fact that you can be certain of Standard's uniformity in manufacture.

ONE OF SIX REASONS why you should always call Standard Steel for rings and flanges.

1. Quality Steel—through production of own steel by acid process.

2. Uniformity—assured by precise control of forging and rolling operations.

3. Testing—radiographic tests, tensile tests, hardness tests, ultrasonic probing of internal structure, etc.

4. Capacity—unsurpassed ability to produce weldless rings all the way up to 144" O.D.

5. Experience—produced by skilled workmen with 20 to 40 years experience.

6. Fast Service—a vital factor in the continuing growth of Standard Steel for over 150 years.

For more information write Dept. 8535

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Wherever Bearing Performance and Cost are Important

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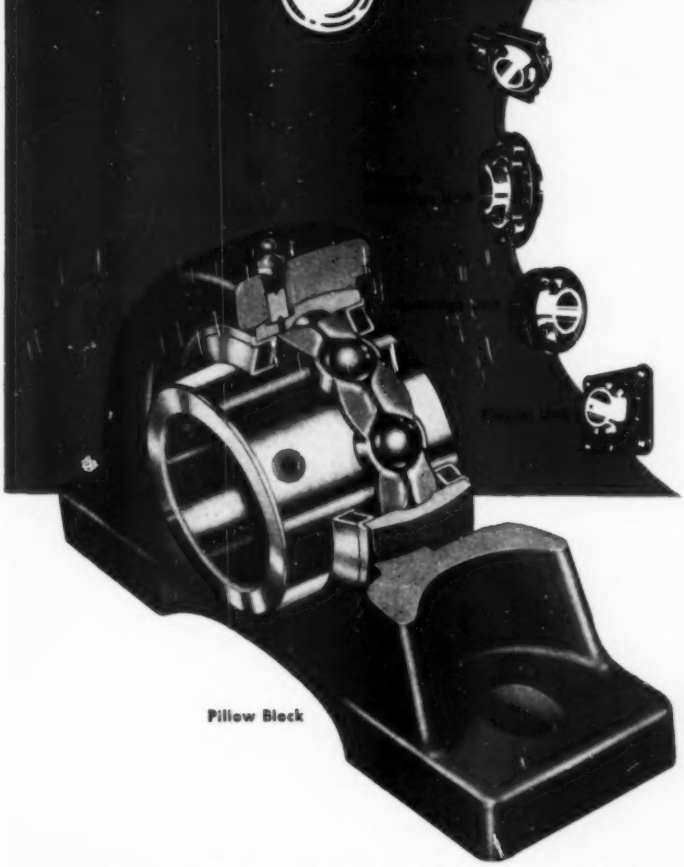


Pillow Block

For ALL These Reasons

1. **PERMANENTLY SEALED**
   to exclude dirt and retain proper amount of lubricant.
2. **SELF-ALIGNING**
   in any direction without seal distortion.
3. **PRE-LUBRICATED**
   with the proper amount of lubricant—for long service.
4. **ZONE HARDENING**
   of ball path section of inner race ring, with extended part of race left soft for better race-to-shaft locking.
5. **NO HOUSING WEAR**
   —patented locking pin and dimple prevent rotation of outer race in housing.
6. **FLOATING BALL RETAINER**
   traps lubricant, prevents churning.

To the thoughtful engineer or operating executive, *each* of these SEALMASTER features is a convincing reason for choosing SEALMASTER Ball Bearing Units. *Together*, this exclusive combination of basic advantages offers sound assurance of top performance *under all conditions*. Write now for your copy of Catalog 845—complete data on the broad SEALMASTER line.

SEALMASTER BEARINGS

A DIVISION OF STEPHENS-ADAMSON MFG. COMPANY • 9 RIDGEWAY AVENUE, AURORA, ILLINOIS

FACTORY REPRESENTATIVES AND DEALERS IN ALL PRINCIPAL CITIES

"customer conscious..."

You are treated like a customer when you deal with The Bunting Brass & Bronze Company. It is a tradition in the Bunting organization to consider the good will of the customer as the most important factor in the transaction. Bunting customers find that Bunting resourcefulness no less than Bunting products, is made available when needed . . . Ask any Bunting customer.

The sleeve bearing is not complex in structure; it conforms readily to design requirements; it is easily installed. Cast Bearing Bronze is the most adaptable of all sleeve bearing materials; it possesses excellent anti-friction properties. With proper film lubrication, its coefficient of friction is as low as can be obtained with any other bearing type. A successful Bunting Bronze bearing installation is readily attainable. We ask the opportunity to work with you, and to quote on your requirements.

Bunting®

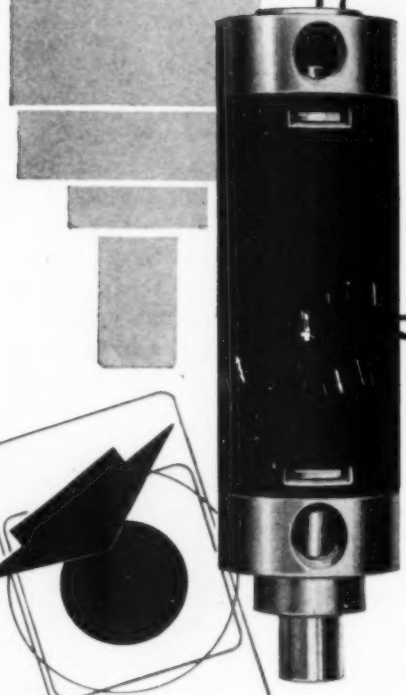
BRONZE BEARINGS • PRECISION BRONZE BARS • BUSHINGS

THE BUNTING BRASS & BRONZE COMPANY • TOLEDO 1, OHIO • BRANCHES IN PRINCIPAL CITIES

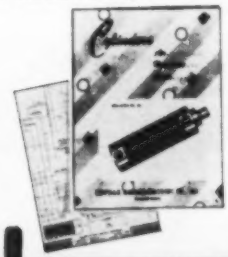
no tie rods...
no bulky end caps...

O-M air • hydraulic CYLINDERS

FIT where others won't!



In close quarters, an O-M Cylinder really shines because it is ALL CYLINDER! The *interlocking mechanism,* which does away with tie rods and projecting end caps, means that *more power is packed into less space.* Saves up to 1/3 installation space. Also provides perfect alignment, friction-free performance. Easier to install and repack. End plugs tapped for universal mounting . . . with a complete range of mounting brackets, interchangeable bore for bore. All machined steel, with bearing bronze (no castings)—easily turned down to fit in deep recesses of machines or bases. Available in full range of sizes (1½" to 8" bores) with standard, 2 to 1 or oversize rods. *Completely interchangeable parts.*



Send today for FREE catalog and complete set of ½ and ¼-scale templates showing all cylinders and mounting brackets.

14-DAY DELIVERY ON MOST SIZES

ORTMAN-MILLER MACHINE CO.
1218 150th Street, Hammond, Indiana

☐ Please send latest O-M Catalog
☐ Please send Complete Set of Templates

Name..... Position.....

Company.....

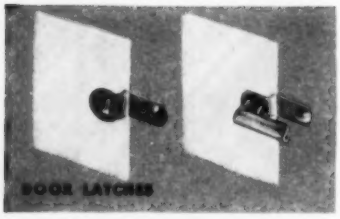
Address.....

City..... Zone.... State.....

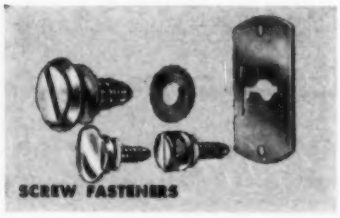
mail coupon now!

when you think of fastening think... SOUTHCO

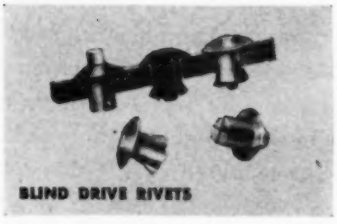
Here is help in securing the *right* fastener for your particular needs in metal-to-metal and metal-to-wood applications. SOUTHCO engineers work with you to find the standard or special fastener that means lowest overall costs.

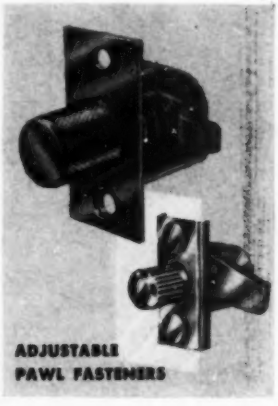


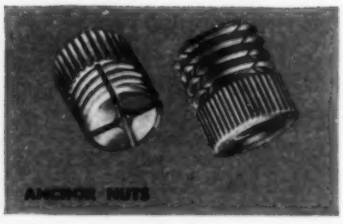
Holding power, speed and ease of installation, elimination of special tooling, convenience of use in opening and closing applications . . . each factor involved is analyzed to assure the best fastener at lowest possible cost. When special designs are indicated, the experience and background of SOUTHCO engineers in solving thousands of fastener problems can be of special value to you.



When you are faced with a fastener problem, write SOUTHCO DIV., South Chester Corporation, 1406 Finance Bldg., Philadelphia 2, Pa. District Offices are located in principal cities.







SOUTHCO
FASTENERS

OFFICES IN PRINCIPAL CITIES . . .

WHEREVER TWO OR MORE PARTS ARE FASTENED TOGETHER, STANDARD AND SPECIAL DESIGNS FOR IMPROVED PERFORMANCE AND LOWER PRODUCTION COSTS

Miller

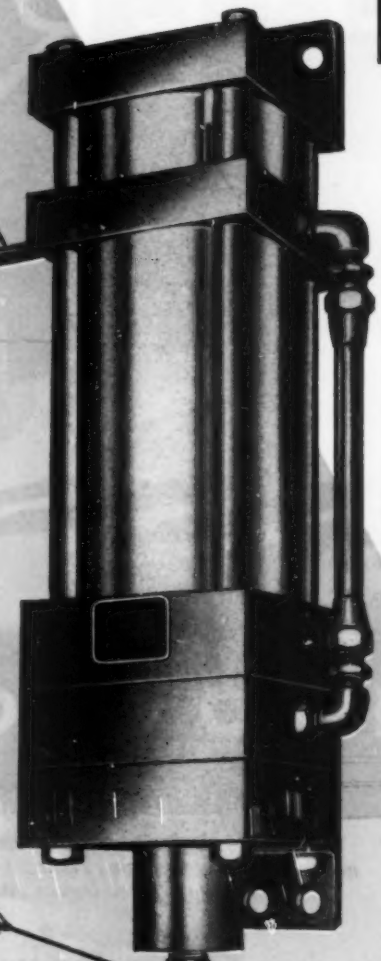
FLUID PRESSURE BOOSTERS

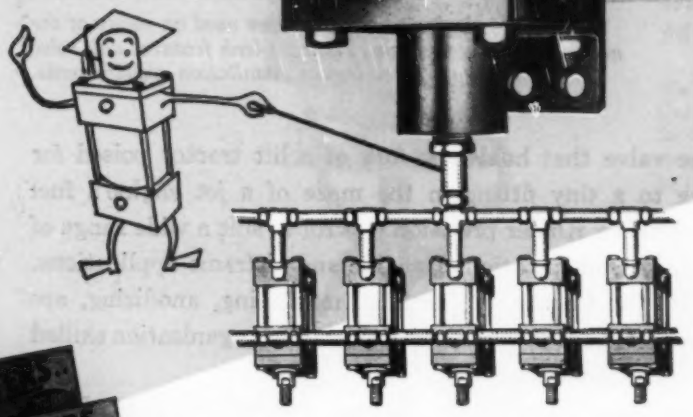
BOOST 80 PSI AIR

Input Range: 40 to 3000 psi Air or Fluid

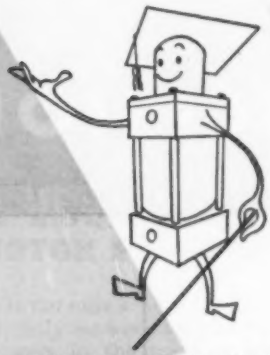
TO 2000 PSI HYDRAULIC PRESSURE

Output Range: 200 to 10,000 psi Fluid





- Save space, weight and investment cost by replacing pump installations in many applications
- Less costly to install, operate and maintain
- **Hold pressure indefinitely** without the motion and heat generation of ordinary pump circuits
- Provide—at point of cylinder thrust—more efficient power with less weight in less space than direct driven air cylinders
- Save up to 95% of air consumed by direct driven air cylinders
- Operate at speeds of 30 to 450 strokes per minute



ESPECIALLY RECOMMENDED FOR

- **WELDING**
- **PUNCHING**
- **SHEARING**
- **CLAMPING**
- **RIVETING**
- **CRIMPING**
- **PRESSING**

and similar applications

FULL DETAILS IN MILLER BULLETIN B-200 SENT FREE ON REQUEST
Other Miller products include: Air cylinders, 1½" to 20" Bores, 200 PSI operation; low pressure hydraulic cylinders, 1½" to 6" bores for 500 PSI operation, 8" to 14" bores for 250 PSI; high pressure hydraulic cylinders, 1½" to 12" bores, 2000-3000 PSI operation. All mounting styles available.

SALES AND SERVICE FROM COAST TO COAST

CLEVELAND • YOUNGSTOWN • DAYTON • PITTSBURGH • PHILADELPHIA • BOSTON • HARTFORD • NEW YORK CITY • BUFFALO • ST. PAUL • GRAND RAPIDS • DETROIT • FLINT • FORT WAYNE • SOUTH BEND • INDIANAPOLIS • MILWAUKEE • LOUISVILLE • KANSAS CITY • SEATTLE • LOS ANGELES • SAN FRANCISCO • BALTIMORE • DENVER • ST. LOUIS • MOLINE • CHICAGO • HOUSTON • TORONTO, CANADA and OTHER AREAS

Miller

MILLER MOTOR COMPANY

2002-04 N. Hawthorne Ave., Melrose Park, Ill.

AIR & HYDRAULIC CYLINDERS • BOOSTERS • ACCUMULATORS COUNTERBALANCE CYLINDERS

Kohler hydraulic check valves used on many of the newer actuating systems. Their no-leak features will solve stringent installation requirements.

Aircraft
Industrial
Automotive

From the valve that holds the fork of a lift tractor poised for unloading to a tiny fitting in the maze of a jet engine's fuel system, there's a Kohler precision control to suit a wide range of hydraulic, fuel, pneumatic, jet engine and airframe applications.

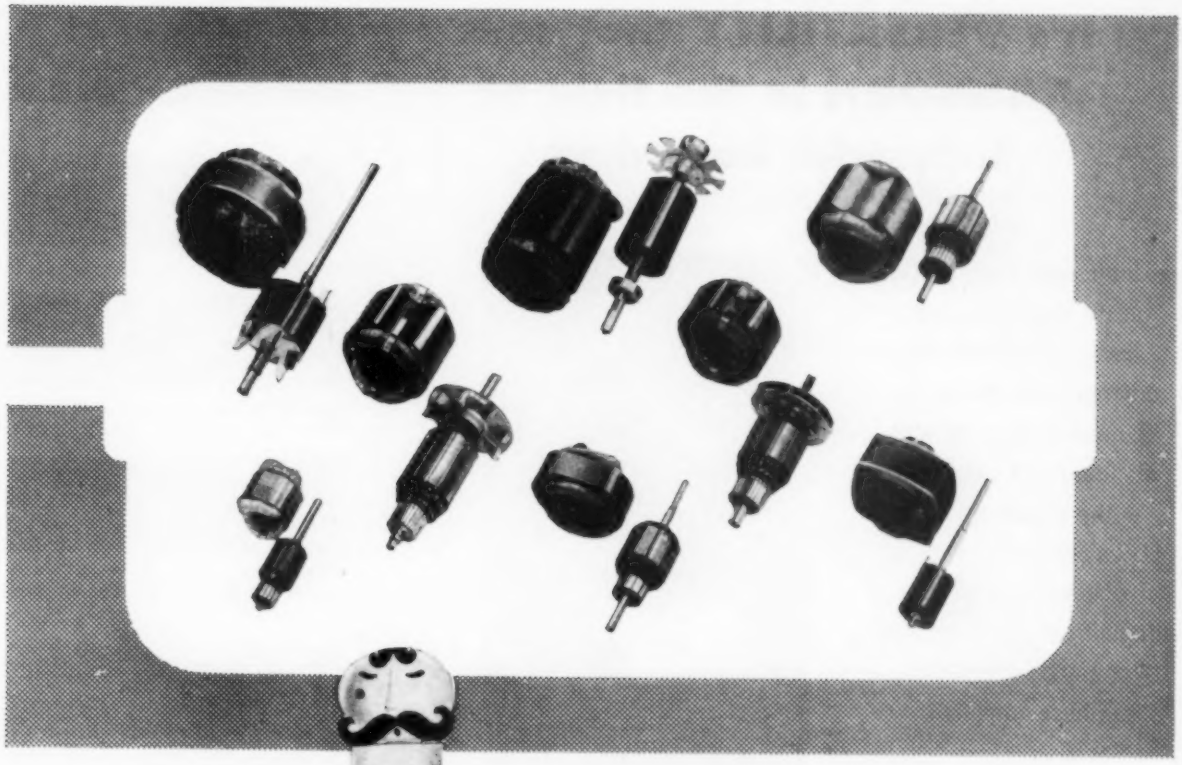
Facilities for forging, die casting, machining, anodizing, are maintained in one plant—with an experienced organization skilled in precision workmanship.

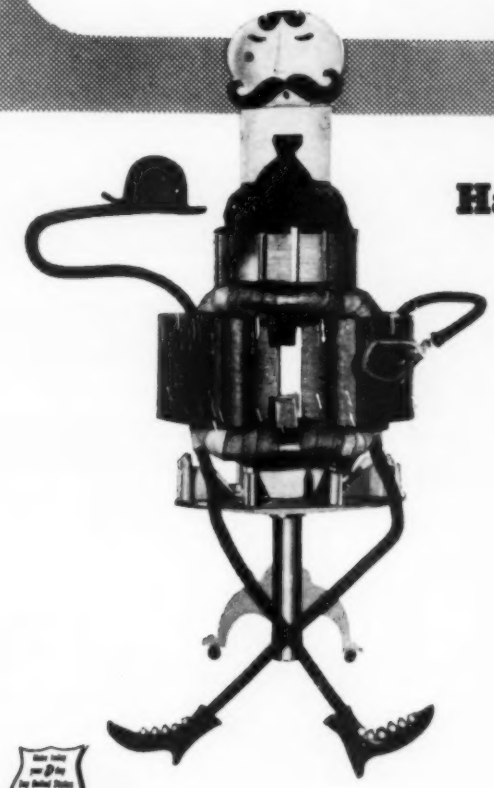
Our engineers develop, for volume production, controls to specification. Write for illustrated booklet.

Kohler Co., Kohler, Wisconsin. Established 1873

KOHLER OF KOHLER

PLUMBING FIXTURES • HEATING EQUIPMENT • ELECTRIC PLANTS • AIR-COOLED ENGINES • PRECISION CONTROLS





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FAMILY

OF EMC AND CYCLOHM MOTOR PARTS SETS?..

We're not only a large family; we're efficient, too. Currently we work for many of the finest manufacturers in the country handling the power requirements of everything from electric shavers to portable power tools.

EMC and CYCLOHM motor parts sets are put together right—built for durability, trouble-free service.

Whatever your needs may be—armatures and fields, rotors and stators, brushes, brush holders, fans, you'll find EMC or CYCLOHM motor parts sets to handle your job.

If your requirements are in the range of ratings from 1/2000 to ½ h. p., check with us today. Write, wire or phone (Racine 2-2731.) We'll have samples and quotations to you promptly.

YOU CAN TELL A MOTOR BY THE COMPANY IT KEEPS!

EMC Universal and Direct Current Motors 1/1000 to 1/2 H. P.
EMC Shaded Pole Motors 1/2000 to 1/15 H. P.
CYCLOHM Induction Motors 1/1400 to 1/4 H. P.

HOWARD

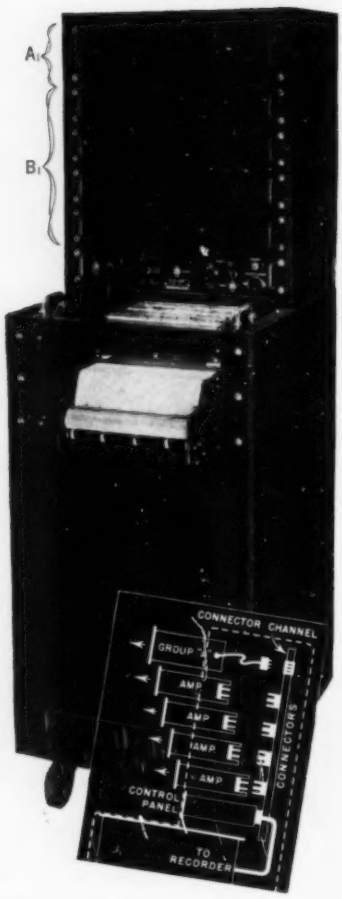
DEPT. PE-3 • HOWARD INDUSTRIES, INC. • RACINE, WISCONSIN
DIVISIONS: EMC ELECTRIC MOTOR CORP. CYCLOHM MOTOR CORP.

It's VERSATILITY that sells SANBORN in the field of Industrial Recording

As indicated by references at the right, you may have a choice of five different instruments (A) for quick and convenient standard rack mounting in the system at A_1, PLUS a choice of up to four of any of the three different type amplifiers (B) or any combination of these amplifiers

with the

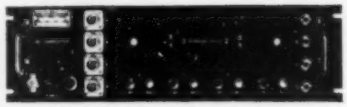
SANBORN
FOUR-CHANNEL
OSCILLOGRAPH RECORDING SYSTEM
(MODEL 67)



A

DC PREAMPLIFIER

AC PREAMPLIFIER



DC CONVERTER—for low level DC recording such as thermocouple output.

TRIPLEXER—when coupled to a DC amplifier permits the recording of three events in one channel.

THRESHOLD MONITOR provides means for the control of voltage levels or rate of change.

B

DC (General Purpose) AMPLIFIER

STRAIN GAGE (Carrier) AMPLIFIER

SERVO MONITOR AMPLIFIER—a phase discriminating AC amplifier used in servo design and testing.

As shown in the diagram, removing or interchanging any of the amplifiers or other instruments is simply a matter of sliding the unit in or out of the mounting rack where contact is made automatically by plug-in connectors. Screws at the four corners of the panel hold the instrument in place.

Other features of this system which add to Sanborn VERSATILITY are the choice of eight paper speeds—50, 25, 10, 5, 2.5, 1.0, 0.5 and 0.25 mm/sec, and the use of either 4-, 2-, or 1-channel recording paper.

And, of course there are these popular Sanborn advantages: a high torque movement (200,000 dyne cms per cm deflection), direct *inkless* recording in *true rectangular coordinates*, and provision for code and time markings.

Sanborn Recording Systems may be used to record any one or more of a wide variety of phenomena whose characteristics range from static to 100 cycles per second. If your recording problem is not one which can be solved by standard Sanborn equipment, our engineers will be glad to suggest ways in which modifications of it may suit your requirements.

A complete catalog of Sanborn Industrial Recording Equipment will be sent gladly on your request.

SANBORN COMPANY
CAMBRIDGE 39, MASS.

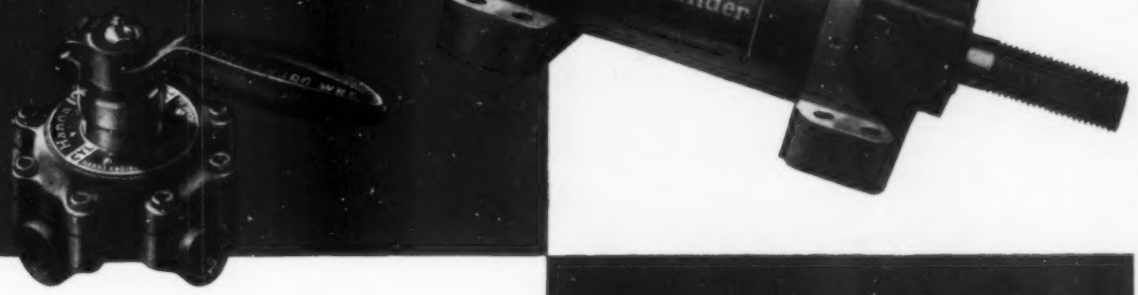
SANBORN 1-, AND 2-CHANNEL RECORDING SYSTEMS

One channel Model 128/141 above and two-channel Model 60 at right both incorporate Sanborn recording advantages which include interchangeability of amplifiers and (with Model 60) preamplifiers.

Hanna

Controlled power

the perfect combination for most efficient power with exacting control!



Hanna valves

Here's Hanna positive control as you need it—for hand, foot, cam or push button actuation . . . to provide manual, semi-automatic, automatic or remote controlled operation. Combined with Hanna pneumatic or hydraulic cylinders, Hanna Valves give you the perfect combination for most efficient power with exacting control.

FREE VALVE CATALOG

Hanna Catalog 254 describes and illustrates the variety of cylinder control valves available for every purpose. Write for your copy today!

Hanna Eng

1763 Elston

HYDRAULIC AND PNEUMATIC EQUIPMEN

where

MISALIGNMENT

can't be helped . . .

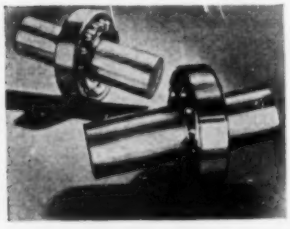
you'll find

SKF

Spherical

Roller Bearings

See how the raceway of the outer ring of this SKF Spherical Roller Bearing forms a section of a sphere. This principle of design of the SKF self-aligning bearings compensates for misalignment due to shaft deflection under load, distortion of the foundation, or other causes.



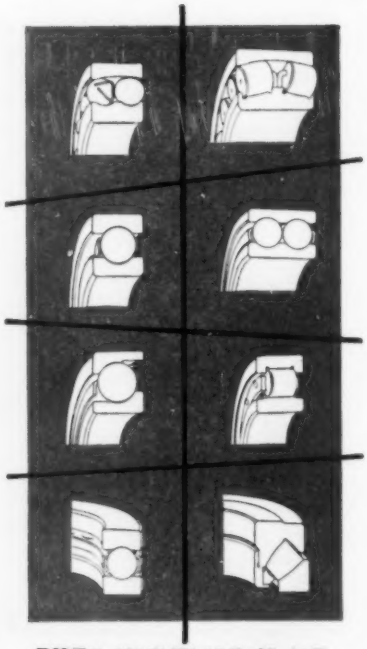
This illustration shows how the principle is also applied to ball bearings, enabling SKF Bearings to operate satisfactorily at high speeds even when some shaft misalignment exists. (The misalignment is exaggerated for clarity.)

Suitable for very heavy radial and thrust loads, SKF Spherical Roller Bearings, like all SKF Bearings, are held well within established tolerance limits, carefully cleaned, protected from rust, and available with cylindrical and taper bores and adapter mountings.

SKF bearings are serving virtually all industry. SKF's unmatched Field and Home Office engineering service helps product designers *put the right bearing in the right place.* **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA.—*manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.* 7403

SKF®

BALL AND ROLLER BEARINGS



SKF'S COMPLETE LINE OF ANTI-FRICTION BEARINGS, PLUS **SKF** ENGINEERING CO-OPERATION, HELPS YOU *PUT THE RIGHT BEARING IN THE RIGHT PLACE.*

ALSiMAG® EXTRUDED CERAMICS

VOLUME PRODUCTION is available for your extruded ceramics at AMERICAN LAVA CORPORATION. Several batteries of presses from 10-ton to 100-ton capacity assure the right press for the job. Ceramics of uniform cross section up to 8½" diameter can be extruded, sawed and machined to intricate shapes. These pictures show part of our extrusion equipment and typical AlSiMag ceramics made from extruded material. Send us your blue prints or sample: let us show you what we can do for you.

51ST YEAR OF CERAMIC LEADERSHIP

AMERICAN LAVA CORPORATION

CHATTANOOGA 5, TENNESSEE

NOTE: New offices at CLEVELAND, OHIO and SYRACUSE, N. Y.

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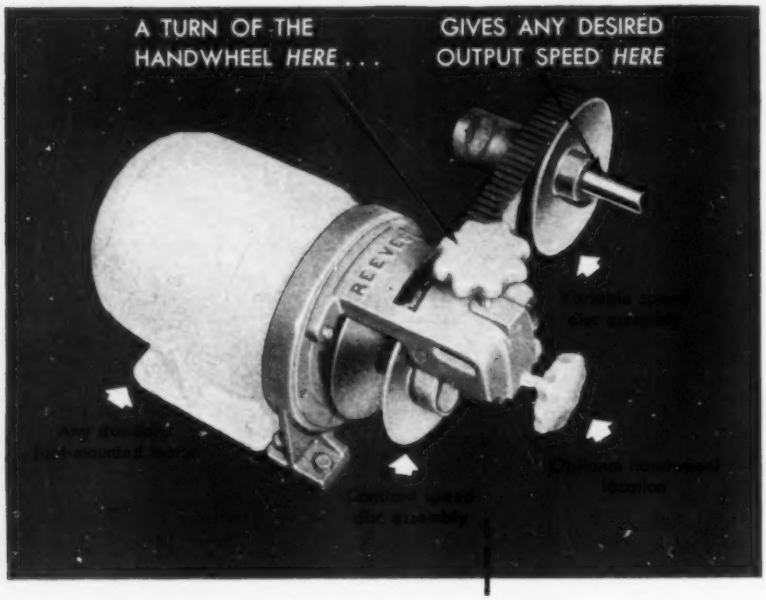
NEW! REEVES
Flexi-Speed Drive

Mounts in any position . . . drives in any direction . . . gives any speed within 8:1 range. *Low Price!*



New REEVES Flexi-Speed Drive is the most versatile variable speed drive on the market today. Drives in any direction. Mounts in any position—above, below or beside the driven machine—practically without limitation. Speed control handwheel and driven shaft may be located anywhere around the motor shaft. Six different length belts offer a wide choice of shaft center distances.

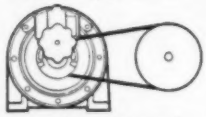
For all these reasons, REEVES Flexi-Speed Drive is the easiest, most practical, and economical way of converting any constant speed motor to an infinitely variable speed drive *with 8:1 speed range*. May be used with any standard ball bearing, foot-mounted motor of ½, ¾ or 1 hp. Identical in working principle to the time-tested REEVES Motodrive, the Flexi-Speed Drive consists of constant speed disc assembly, variable speed disc assembly, double-cog belt and versatile shifting mechanism.

REEVES Flexi-Speed Drive is ideal for driving to standard gear reducers for parallel drive, on worm gear reducer for inexpensive right angle drive. Its versatility assures maximum production with the greatest efficiency and economy in your machines. Write today for complete details. Specify Dept. K90-V532.

REEVES PULLEY COMPANY, COLUMBUS, INDIANA

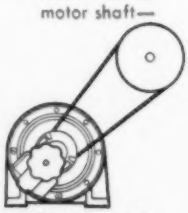
REEVES SPEED CONTROL

Some of the mounting positions

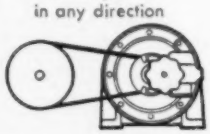


Handwheel control may be located anywhere

360° around motor shaft—



Belt may drive in any direction



650° F.
STEADY OR WITH RAPID FLUCTUATIONS
MYCALEX INSULATION CAN TAKE BOTH OF THOSE TEMPERATURE CONDITIONS

It holds inserts tightly, and moves with the metals around it, because it has very nearly the same coefficient of thermal expansion as the most important metals of which inserts and casings are made.

DESIGNER! UNCHAIN YOUR IMAGINATION!

The destructive effects of high operating temperatures, high ambient temperatures, thermal expansion as between metals and insulations, have caused you to make too many items too much bigger and heavier than they need to be.

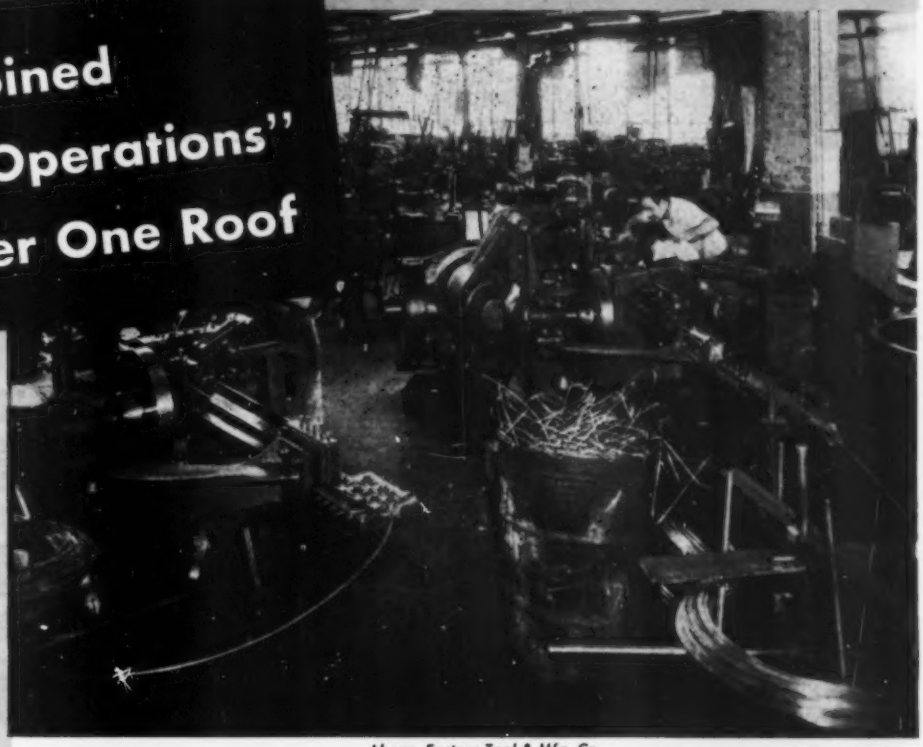
MYCALEX glass-bonded mica also is dimensionally stable, corona resistant, does not carbonize under arc, has no moisture absorption.

THERE ARE PLENTY OF OTHER USEFUL FEATURES . . . WRITE for the whole story

SINCE 1919
MYCALEX
THE INSULATOR ®

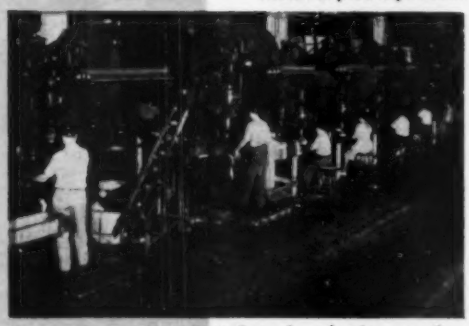
MYCALEX CORPORATION of AMERICA
World's Largest Manufacturer of Glass-bonded Mica Products
Executive Offices: 30 Rockefeller Plaza, New York 20, N.Y.
GENERAL OFFICES AND PLANT
125 CLIFTON BOULEVARD, CLIFTON, N.J.

"Combined Operations" Under One Roof



Above: Eastern Tool & Mfg. Co. Wire Forming Department

Section of press department.



Part of our deep drawing operations.

Wire Forming

Metal Stamping

Deep Drawing

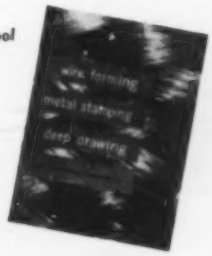
Eastern Tool & Mfg. Co. combines the essential functions of large quantity metal parts manufacture under one roof.

We are equipped to render our customers a complete service, from design through manufacture and assembly, if required, to final finishing in our completely equipped plating department.

Our wire forming department is the largest of its type in the country, having over 150 automatic four-slide machines, capable of handling almost every variety of round, flat and specially shaped wire in many metals.

Ad No. 1 of a series designed to acquaint you with Eastern Tool & Mfg. Co.

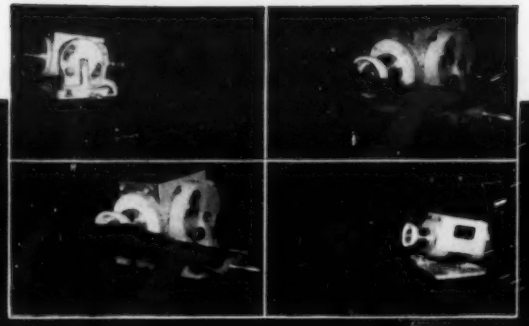
Send for the new 24 page Eastern Tool & Mfg. Co. descriptive booklet.

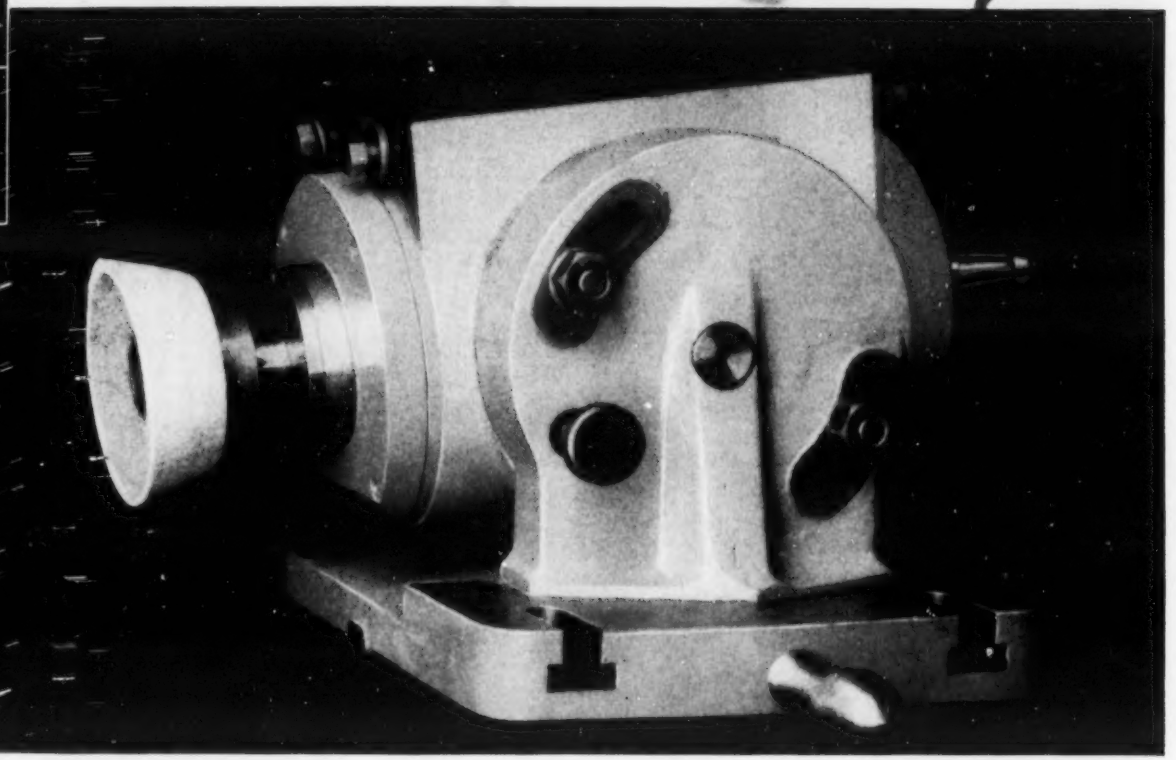


Eastern Tool & Mfg. Co.

Belleville 9, New Jersey

The TOOL GRINDER For *You!*





The Modern POPE Super Precision 1 HP, 3600 RPM Motorized Tool and Cutter Grinder Head With

Angular Adjustment

In A Vertical Plane

This new unit is super-precision throughout... It is designed particularly for replacement of tool grinder heads which do not have the extremely useful angular adjustment in a vertical plane.

It will more than pay for itself — reduces set-up time — makes wheels cut faster — spark out quicker — produces the kind of cutting edge on your tools that stands up and cuts longer

Pope Motorized Grinder Heads are available for most makes of cutter and tool grinders. Ask for quotation to cover your grinder.

No. 92

Specify **POPE** PRECISION SPINDLES

POPE MACHINERY CORPORATION

261 RIVER STREET • HAVERHILL, MASSACHUSETTS

Honeywell controller regulates flow of cooling water

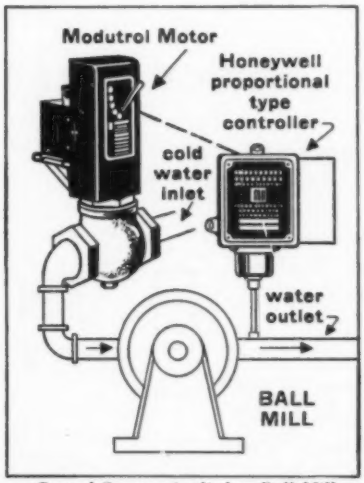
As paint is ground in steel ball or pebble mills, considerable heat is developed. The resulting temperature variations can change the efficiency of grinding—with corresponding effects on quality of paint.

The control system which Western Paint and Varnish Co. of Duluth, Minnesota, has worked out is simple but effective. Water running through the cooling jacket around the grinding mill takes away the heat of grinding. But since the process continually produces more heat, less water is needed at the start than at the end of the run.

A Honeywell remote bulb proportioning type controller is installed with its bulb in the outlet water line. The controller regulates water flow, by means of a *Modutrol* motorized valve in the incoming cold water line.

Proportional control action keeps water temperature steady throughout the process. As the grinding heat increases, outlet water temperature starts to rise. The controller then calls for more water by directing the *Modutrol* unit to open the valve further. The net result is that temperature never fluctuates more than a few degrees . . . grinding conditions stay at the right values to produce consistently high production quality.

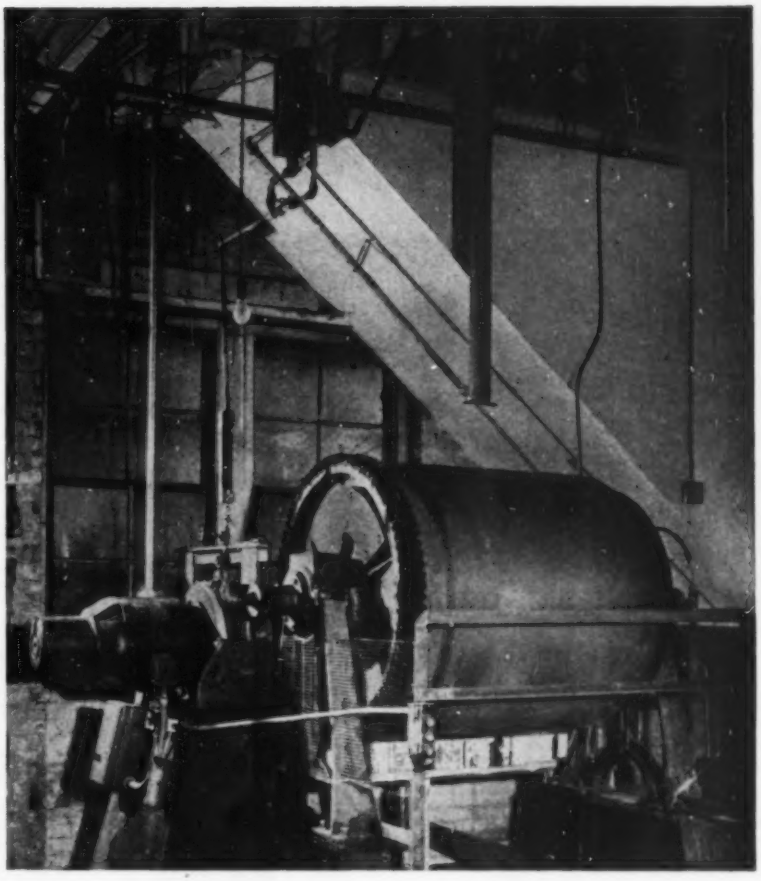
The simplicity of this arrangement is typical of the ways that the more than 7000 Honeywell control devices can be utilized in an endless variety of applications. And these controllers are completely dependable; they're ruggedly built in every detail . . . and they're backed by Honeywell's nationwide service organization.



Control System Applied to Ball Mill

WOULD YOU LIKE TO RECEIVE "Industrial Control News"?

You'll find a wealth of ideas on how to use automatic control devices in *Industrial Control News*. If you're not already receiving this informative magazine, just send your name, company, title and address to MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Station 213, 4459 Wayne Ave., Philadelphia 44, Pa.



Paint grinding improved by Honeywell temperature controller

Holding accurate temperatures in a paint grinding mill makes a big difference in quality of paint. But, as the Western Paint and Varnish Co. found, a simple Honeywell remote bulb temperature controller coupled with a matching *Modutrol* motorized valve can do this job economically—and with ample precision to assure top efficiency.

Countless other plant operations and products can be improved . . . simplified . . . made safer or more automatic . . . through the use of Honeywell devices for controlling temperature, pressure, liquid level, vacuum, and humidity. Our local engineering representative will be glad to discuss your applications in detail. Call him today . . . he is as near as your phone.

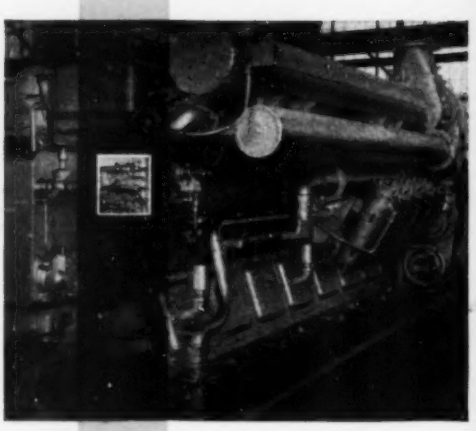
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4459 Wayne Ave., Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for your copy of Catalog 8304, "Industrial Controls."

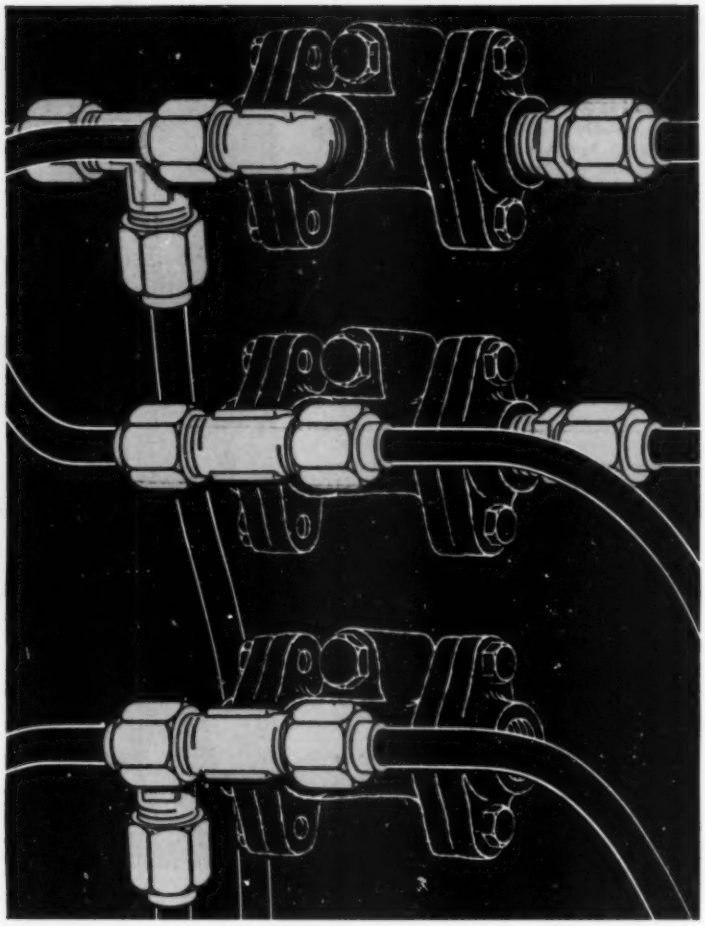
MINNEAPOLIS **Honeywell**

First in Controls

ON DIESEL ENGINES



This typical Diesel engine manufactured by The National Supply Company, Engine Division, Springfield, Ohio, is equipped with Parker Triple-lok Fittings.



Tube it up...Forget it...WITH PARKER

TROUBLE-FREE TRIPLE-LOK FITTINGS

Diesel service is rugged. Constant vibration puts a severe strain on all engine parts, including fittings connecting fluid handling lines. Yet no leak, however small, can be tolerated.

That's why so many Diesel engine manufacturers rely on Parker Triple-lok Fittings . . . the fitting that meets specifications of the A.S.M.E. Code for Pressure Piping, and J.I.C. and S.A.E. standards. They are leakproof under severest conditions of vibration, elevated temperatures, high pressures and repeated assembly.

So *tube it up* and *forget it* . . . with Parker Triple-lok Fittings. Ask your Parker Distributor for Tube Fitting Catalog 4300, or write The PARKER Appliance Company, 17325 Euclid Ave., Cleveland 12, O.

This does it

Triple-lok . . . 3-piece flare fitting famous for its sleeve . . . the easiest way to install tubing systems. Made in brass, steel, stainless steel, aluminum alloy.

Precision Mark of

Leakproof Tube Fittings

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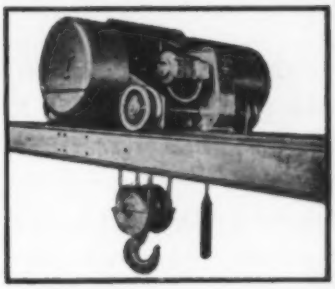
FROM START TO STOP

with a

BROWN BOVERI

QuickSTOP MOTOR



Electric trolley hoist driven by three QuickSTOP Motors.

Here's the combination BRAKE & DRIVE, all-in-one motor that's designed to "take it" in tough industrial service.

QuickSTOP Motors require no outside power source or special controls for applying or releasing their brakes. They release their brakes and start instantly when power is applied. When power is cut, they stop and brake with 150% of normal torque. Absolutely no creep or backlash. Like any standard 3-phase motor, they can be reversed.

Suitable for reversing operations. Vertical or horizontal mounting. QuickSTOP Motors are available as drip-proof motors from .3 to 8 HP or as totally enclosed motors from .2 to 4 HP.

Where fast stops and starts are a problem—on original equipment or for replacements—it pays to install Brown Boveri QuickSTOP MOTORS. Get the facts about these world-famous, dependable, trouble-free motors.

QuickSTOP Motors are now used in

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Above-average efficiency . . .
. . at no increase in cost

Normally you'd expect to pay a premium for the precision found in Rollway's TRU-ROL. Not so, however. These long-life steel-cage bearings are competitively priced. Their exceptional performance and low cost are the result of three distinctive Rollway advantages:

FIRST Advanced metallurgical facilities and mass production by modern, high-speed, high-precision machinery.

SECOND Experience since 1908—during good times and bad—in the practical application of cost-cutting methods.

THIRD Tru-Rol's contoured guide lips which insure constant roller alignment and extended life. They prevent undue wear caused by skew, slide and end-rub . . . encourage cooler operation by spreading a thin film of lubricant evenly over the rollers.

ENGINEERING SERVICE . . . Rollway TRU-ROL Bearings are available with steel cages or steel-segment retainers—a choice that fills a wide range of tractor requirements at the lowest possible cost. If you have a particular problem, contact us. A Rollway engineer will be available for consultation with you —without obligation, of course. Rollway Bearing Company, Inc., Syracuse 4, N. Y.

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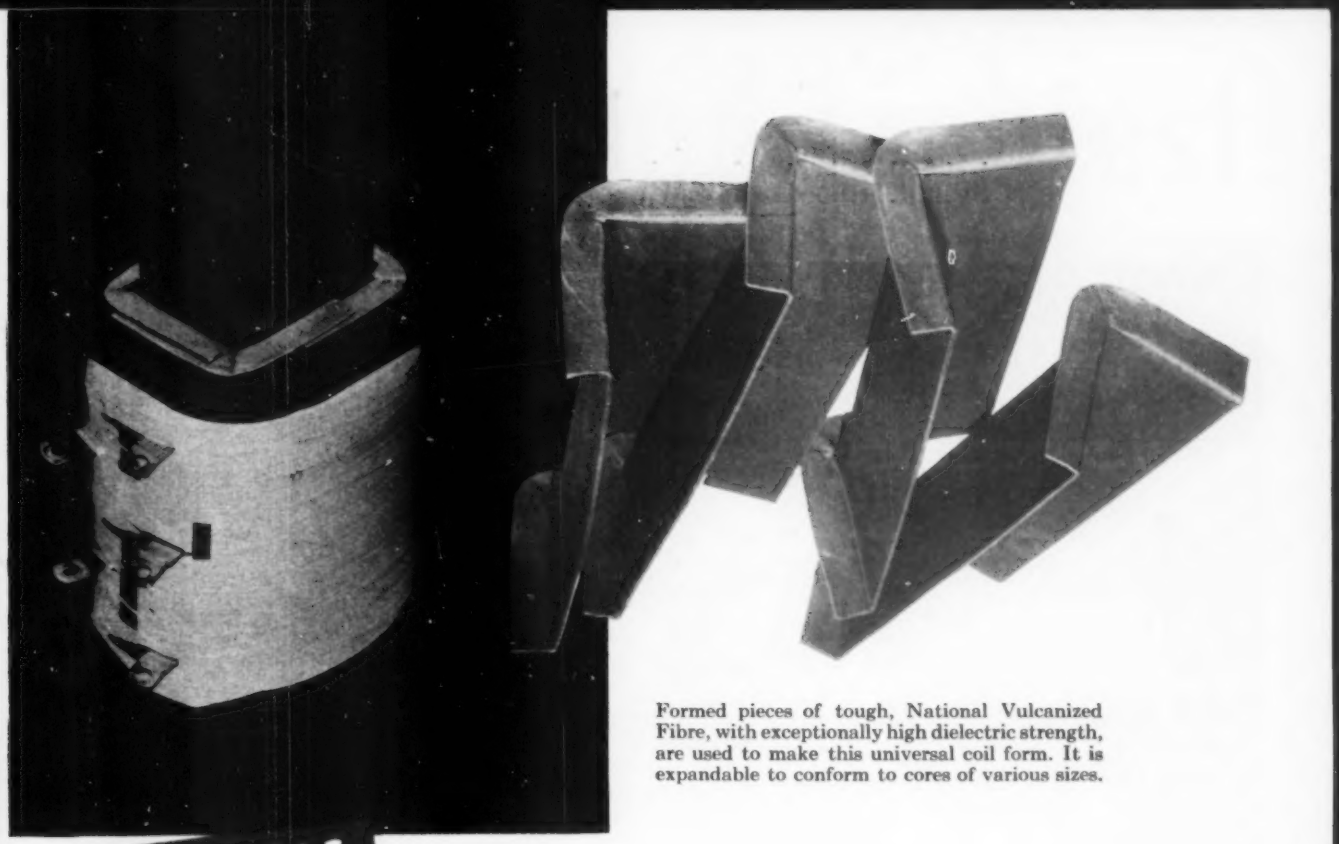

Formed pieces of tough, National Vulcanized Fibre, with exceptionally high dielectric strength, are used to make this universal coil form. It is expandable to conform to cores of various sizes.

NATIONAL VULCANIZED FIBRE

contributes to an improved product—in universal coil forms for Cutler-Hammer, Inc.

This practical use of National Vulcanized Fibre by Cutler-Hammer, Inc. in their wire spools is typical of the countless contributions National Vulcanized Fibre—*the material of a million uses*—makes to business and industry.

In the electrical field National Vulcanized Fibre has been the standard insulation for years. It has high dielectric strength and, when subjected to hot electrical arcing, it evolves neutral gas which extinguishes arc without "tracking." Many electric appliances find National Vulcanized Fibre to be the one best material for one or more of their parts.

National Vulcanized Fibre applications, both mechanical and electrical, are varied and extensive. In mechanical applications it is desirable because it possesses exceptional tensile and crushing strength, toughness, density and resistance to wear—coupled with ease of fabrication. It actually improves with age; for many mechanical purposes it is better, more durable than metal.

Available in various grades and colors; and in sheets, rods, tubes and special shapes. Write for detailed literature and engineering service information—

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Wilmington Delaware

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Since 1873

National Laminated Plastics nationally known—nationally accepted

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The newest Fiber Glass plant in the world is Pittsburgh Plate Glass Company's at Shelbyville, Indiana. The first unit of this plant was placed in operation last autumn. Today, within less than six months, PPG Fiber Glass is available to serve the varied needs of industry for Superfine Insulation and for Yarns, Strands and Roving.

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PPG's research will be equally important in the continued development of its newest product, Fiber Glass. Your business may be among the first to profit. Your inquiries are invited.

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PITTSBURGH PLATE GLASS COMPANY

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AMP CAPITRON* Capacitors and Pulse Forming Networks are particularly suited for radar and guided systems not only because of their remarkable size and weight characteristics, but also because of their outstanding stability and reliability in operation. AMP Pulse Forming Networks are fabricated with AMPLIFILM*, a startling new synthetic dielectric, chemically similar to mica, which imparts its unique combination of extremely high dielectric strength, stability over wide temperature ranges, low power factor, and good dielectric constant to these products. They are designed in each instance for the specific requirements as to size, shape, working or test voltage, capacitance, life or other operating conditions of the equipment in which they are to be used. Inquiries are invited.

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AMP is also nationally recognized leader in the field of solderless terminals, simplified wiring devices and automatic wire termination. Write for our "Quality Control" brochure.

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save machining cost for **ROTRON!**

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PARKER ALUMINUM *and* ZINC *Die Castings*

Do you hesitate to use ELECTRONIC CONTROLS in your product because of the problem: "What happens when the controls cease to function?"

Now—RELIABILITY IN SERVICE for your Electronic Controls through Alden Components for Plug-in Unit Construction

A whole new CONCEPT

ALDEN PLUG-IN UNIT CONSTRUCTION

—giving these vital advantages:

1) If Electronic Controls fail, your customer is able to restore operation in 30 seconds by plugging in replacement spare.

2) Visual signals tell instantly what needs replacement or adjustment.

3) Non-technical personnel can accomplish restoration of service.

4) Individual units are compact enough to be airmailed to you for servicing.

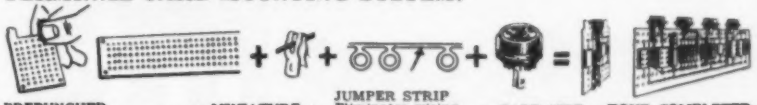
These design standards are absolutely vital to any manufacturer planning to incorporate electronic circuitry into his equipment, and expect to send that equipment out into shops, offices and all sorts of distant locations and have it reliable in operation. Electronic controls are wonderful when working smoothly. When they go awry, it's usually some minor flaw, the tiniest thing . . . but can be a headache . . . unless you provide for easy finding and fixing, by designing to Alden Plug-in Unit Standards; using—

The COMPONENTS to make it work!

We have spent four years evolving the design principles of Alden Plug-in Unit Construction and have perfected a completely integrated line of components to mount, circuitize, house, fasten, monitor and connect all types of electronic devices, from simple recorder to giant computer. These components are already tooled and in production. No procurement headaches—prompt delivery—sometimes from stock.

How Reliability in Service is built into your controls

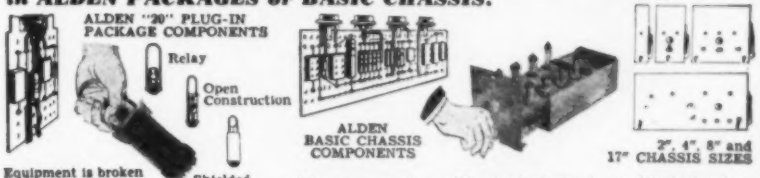
Your circuitry is unitized in compact vertical planes using ALDEN TERMINAL CARD MOUNTING SYSTEM.



PREPUNCHED TERMINAL MTG. CARD + MINIATURE TERMINALS + JUMPER STRIP Eliminates wiring for common circuits + CARD-MTG. SOCKETS = YOUR COMPLETED CIRCUITS

You can use Alden Terminal Mounting Card with Alden Miniature Terminals, Jumper Strip and Sockets staked to accommodate any circuitry—making complete units ready for housing. Components snap into unique Alden Terminals, are held ready for soldering.

Your circuits become easily replaceable plug-in units by mounting in ALDEN PACKAGES or BASIC CHASSIS.



Equipment is broken down into easily replaceable plug-in units

Alden components provide standard plug-in or slide-in housings —with spares, your circuits become units replaceable in 30 seconds.

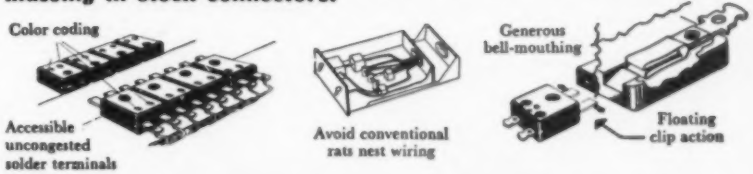
Color-coding quickly identifies replacement units — non-interchangeability of connectors positively prevents mis-matings.

Choice of variable pin patterns guarantees against mis-mating
Socket to match Base pattern
ALDEN UNIT CABLE
Variety of connectors assures plugging in only where intended.

Your plug-in units are monitored with ALDEN SENSING ELEMENTS that spot trouble instantly.

MINI-TEST POINT for instant voltage checks
"PAN-I-LITE" Miniature Indicator Light
"FUSE-LITE" INDICATING FUSEHOLDER Fuse blows—lite glows

ALDEN SLIDE-IN BACK CONNECTORS give central color-coded check point of incoming and outgoing circuits, eliminate blind massing in block connectors.

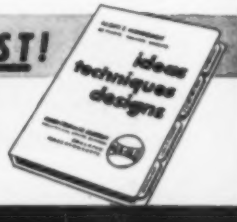


To be practical, Electronic Controls MUST be designed and built for RELIABILITY IN SERVICE. Alden Design Standards, Alden Components are the answer.

To design for RELIABILITY IN SERVICE, this Handbook is a MUST!

Here are 226 pages unfolding in comprehensive detail the plug-in unit principles to assure RELIABILITY-IN-SERVICE in any electronic device. Complete specs of all the related components are included. With this Handbook an engineer can readily design any electronic device or circuitry to include the vital advantages of plug-in unit construction.

SEND FOR YOUR FREE COPY TODAY



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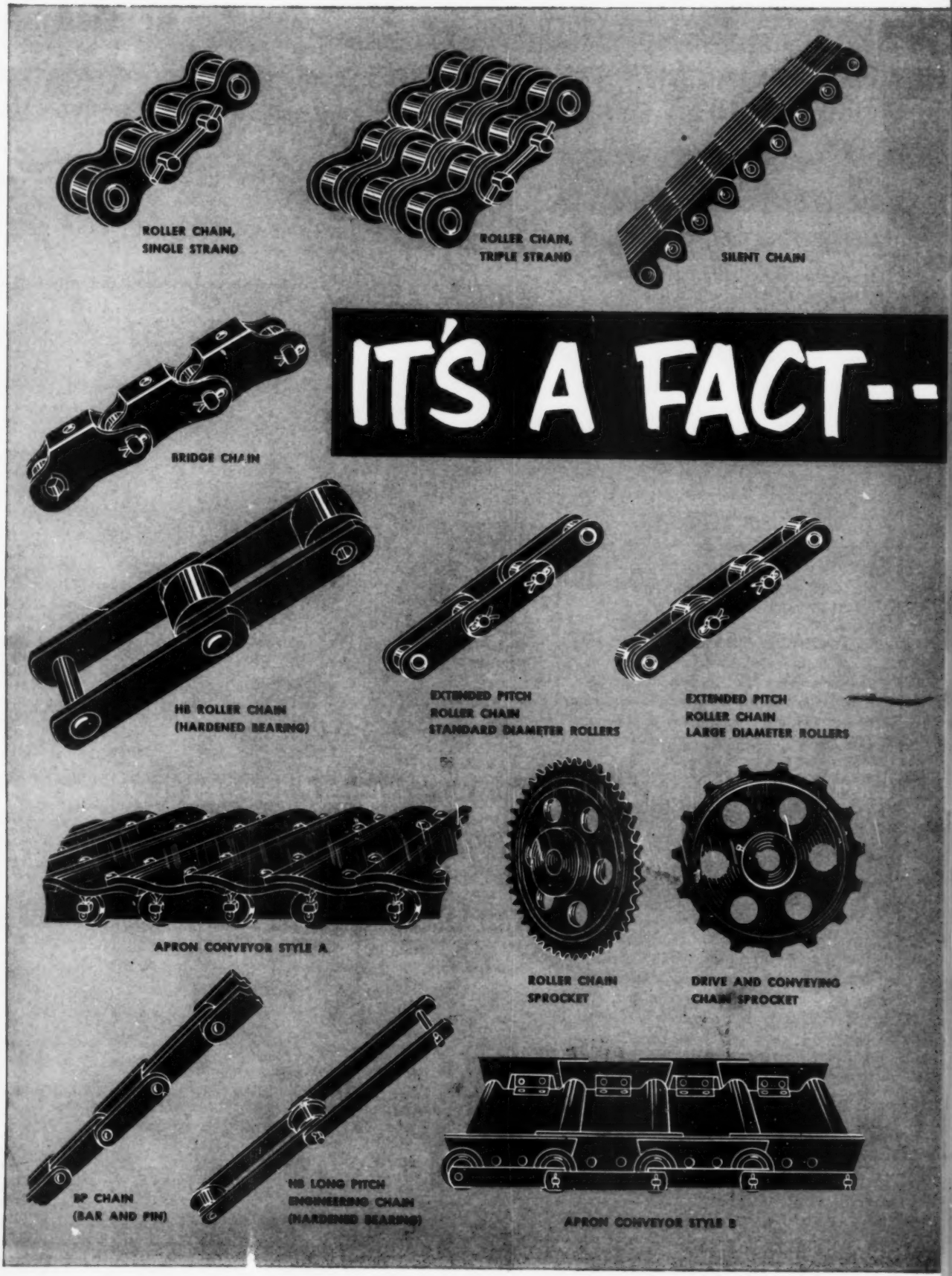
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ROLLER CHAIN, TRIPLE STRAND
SILENT CHAIN
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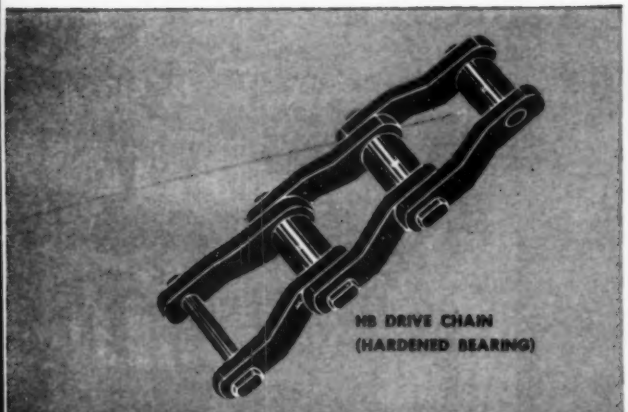
EXTENDED PITCH ROLLER CHAIN LARGE DIAMETER ROLLERS
APRON CONVEYOR STYLE A
ROLLER CHAIN SPROCKET
DRIVE AND CONVEYING CHAIN SPROCKET
BP CHAIN (BAR AND PIN)
HB LONG PITCH ENGINEERING CHAIN (HARDENED BEARING)
APRON CONVEYOR STYLE B



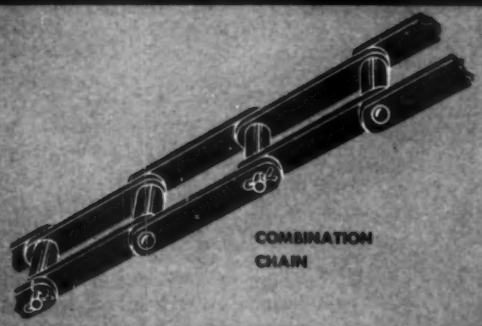
HB DRIVE CHAIN
(HARDENED BEARING)

THERE ARE 404 CHAINS LISTED IN OUR CATALOGS AND PRICE LISTS

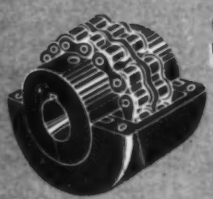
. . . and we will recommend the best one for your job . . .

It doesn't matter to us which power transmission or materials handling chain is best for your job but it does to *you*. For almost invariably there is one chain which will perform best and last longer on a given application. And that's the chain we'll recommend. We'll recommend it because we make it.

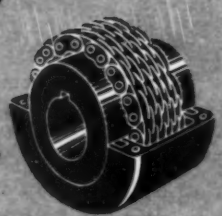
The thing to remember about UNION is that UNION makes every type of steel chain and attachment for the transmission of power and the mechanical handling of materials. (And nothing else, incidentally. We're complete chain specialists.) So you might well wish to put your next chain assignment in our hands. If you do, you'll get prompt attention from a UNION representative (see list below) or from the home office. *The Union Chain and Manufacturing Company, Sandusky, Ohio.*



COMBINATION CHAIN



ROLLER CHAIN
FLEXIBLE COUPLING



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to solve vibration-joint fastener problems

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● Find out about Place Bolts *now!* New users and new uses are multiplying daily. A cold-forged fastener made of either high carbon or alloy steel, the Place Bolt head brings *diaphragm spring action* to bear on seating surfaces while elastic elongation of the shank safeguards against loss of initial bolt-tension. Vibration-and-shock-proof holding power is assured. Sizes range from ¼" diameter upwards, standard or special. Write today for our Place Bolt Folder.

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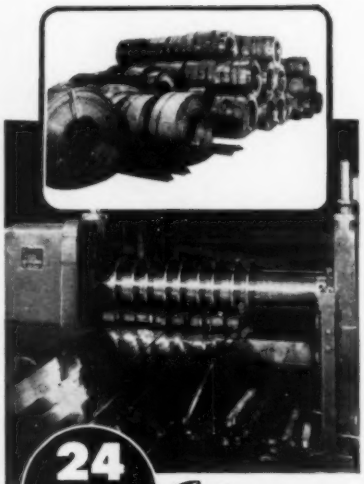

24 HOUR *Slitting Service!*

If you operate a slitter of your own, you may always enjoy this kind of service. Think what a blessing it is to be able to meet expected and unexpected needs for slit strands on such short notice—how greatly it simplifies production planning—how it eliminates production bottlenecks and minimizes strip inventories.

Then, too, when you buy strip in standard widths, your strip supply sources are more numerous. You can buy wherever you get the best delivery, price, and quality.

Slitting service now may cost you anywhere from $10.00 to $100.00 or more per ton. Even if your needs were only 50 tons per month, at an average of $20.00 per ton for slitting, the cost per year would be $12,000—an amount which alone may be more than sufficient to make a Yoder slitter highly profitable.

The Yoder Slitter Book (sent on request) analyzes and discusses the economics as well as the mechanics of slitter operation. Yoder engineers will be glad to study your needs and submit recommendations as to kind, size, and cost of suitable slitting equipment.

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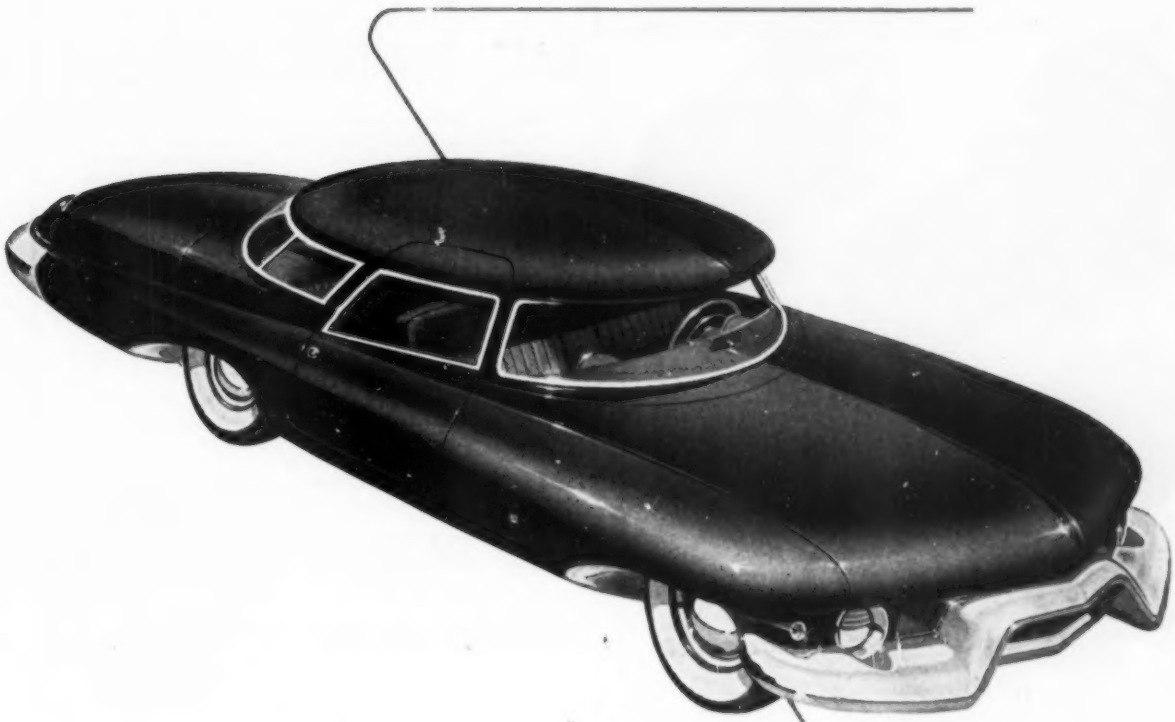
Specify **N·A·X** HIGH-TENSILE STEEL for **Lighter Weight**

Longer Life

with Economy



N-A-X HIGH-TENSILE, with its 50 percent greater strength than that of mild carbon steel, means that thinner sections can be used . . . resulting in lighter weight of products. Because it is an alloy steel, it possesses much greater resistance to corrosion with either painted or unpainted surfaces. It has high fatigue and impact values, at normal and sub-temperatures, with the abrasion resistance of a medium high carbon steel . . . resulting in longer life of products.

N-A-X HIGH-TENSILE has outstanding cold-forming properties, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than possible with mild carbon steel.

Your product can be made lighter in weight . . . to last longer . . . and in some cases, be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

MAKES A TON OF SHEET STEEL GO FARTHER Specify N·A·X HIGH-TENSILE STEEL ... And "MAKE YOUR PRODUCT LAST LONGER"

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FRACTIONAL FRAME SIZES IN STANDARD OR SPECIAL* DESIGNS!

* Motors shown have special adapter, special shaft. Eccentricity of machined face with respect to shaft held to very close tolerance by taking qualifying cut after motor is completely assembled.

GRAHAM TRANSMISSIONS INC. selected this complete line to motorize its widely-used variable speed transmissions. Starting with one frame size only, Graham has been a steady user of Doerr motors for many years.

Many other leading machinery builders continue to place their confidence in Electro Machines products and service as proved by the high percentage of repeat orders.

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Electric Motors
1/30 to 5 hp.
Standard or Designed to
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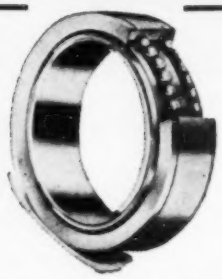
Explore the possibilities of this NEW DEVELOPMENT



. . . a series of ANTI FRICTION BEARINGS for use where space is limited . . .

BALL BEARING BUSHINGS

This new series of Double Row (DR-L) Light Ball Bearing provides efficient anti-friction performance within a section height as little as ¼". Ample grease capacity assures long life and eliminates the constant danger of "no lubrication" in the hard-to-get-at places.
Available with bore tolerances made for press fit on selected shafting for shaft rotation; and loose fit on cold rolled shafting for outer race rotation application.

Send for illustrated literature, sizes and capacities. Consult our engineers on your application problems.

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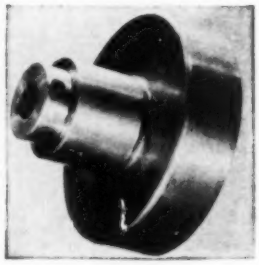

We're not just selling clutches here at Mercury—we're selling clutch know-how! For years Mercury engineers have been recommending clutch applications that assure smoother operation, greater efficiency.

- Mercury Clutch on electric motors gives easier starting
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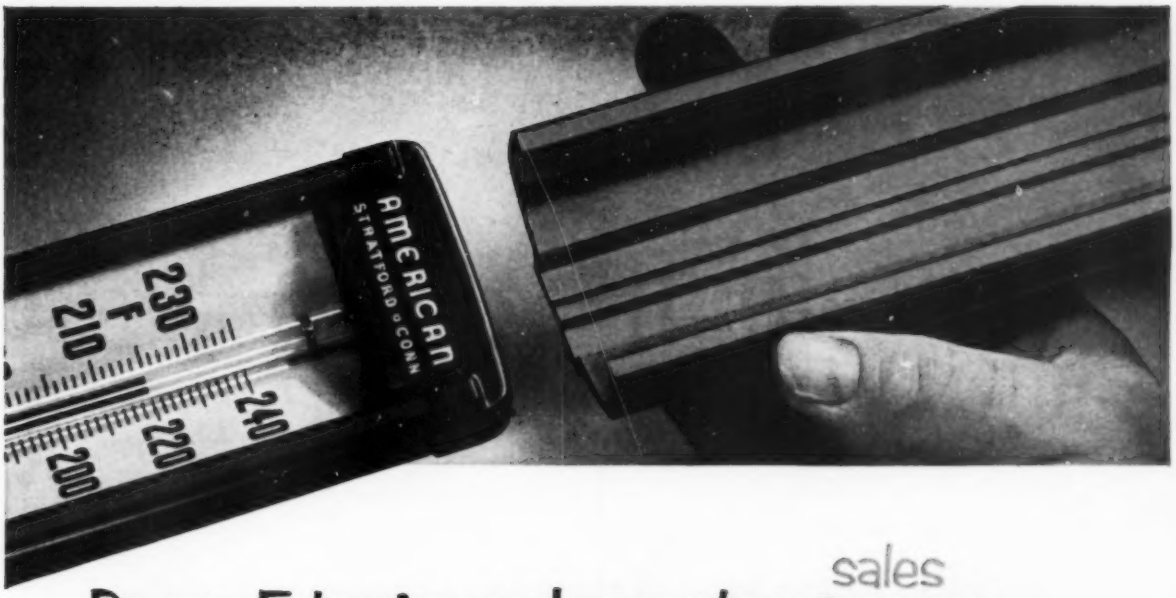
- Eliminates burned out motors and fire hazard
- Cuts costs—smaller motor with increased efficiency
- Mercury Clutch on gas engine equipment—equal advantages

It's all in the know-how. That's why it will pay you to put your clutch problems up to the men who know clutches best—Mercury engineers. Write today for full information.

Mercury has the Answer!

Mercury Clutch Division
AUTOMATIC STEEL PRODUCTS, INC.
CANTON 6, OHIO



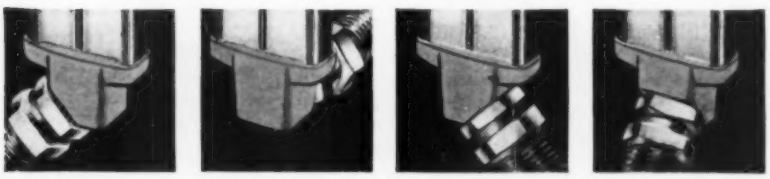
Bronze Extrusion makes a stronger sales case for this industrial glass thermometer

The case for this "American" Industrial Glass Thermometer made by Manning, Maxwell & Moore, Incorporated, Stratford, Conn., used to be a steel stamping. Now it's made of ANACONDA Extruded Bronze.

Why the change? Because this extruded bronze shape makes a far stronger and more rigid case; it's easier to produce; it simplifies assembly—and adds additional quality to an already high-quality product. So accurate are these bronze extrusions that neither straightening nor machining is needed for assembly. And assembly time itself is cut.

For the base, an ANACONDA Brass Die Pressed Forging is joined to the case by brazing to provide greater joint strength. By machining the appropriate face of a single-style base forging, a stem connection can be provided at any angle.

ANACONDA Brass and Bronze have long been making a stronger "case" for products—by simplifying production; by the higher quality that is always associated with products made of brass or bronze; by increasing sales appeal. We urge you to consider the advantages of these metals for your manufacturing processes and your products. For information, write to The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 5387



Base forging can be machined to provide stem connection at any angle and direction.

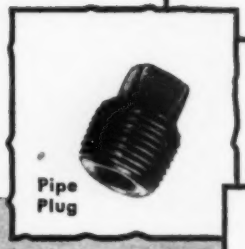
Extruded case and forged base for this 9-in. "American" Thermometer are joined in perfect alignment by brazing. No machining or straightening is required.

ANACONDA® —the name to remember in **COPPER—BRASS—BRONZE**

Self-Locking Self-Sealing

LOK-THRED

IN ANY SIZE STUD, BOLT OR SCREW



Look into LOK-THRED, and the important advantages it can offer your products. For example, LOK-THRED can end the difficulties you may be having with involuntary loosening of fasteners . . . leakage of lubricants or other fluids via ordinary threads . . . or even a combination of both.

LOK-THRED *seals as it locks* . . . reforms the receiving thread into an intimate metal-to-metal contact with itself to eliminate every void between the mating threads.

LOK-THRED *can't shake loose,* either . . . actually becomes tighter in service when it is subjected to severe vibration and jarring. Yet it is fully reusable . . . requires no selective fits . . . can be used with ordinary tools.

National offers LOK-THRED and its unique advantages in all sizes of studs, bolts or screws. Why not take a detailed look at all the features of LOK-THRED . . . write today for National's booklet containing complete engineering and application data.

THE NATIONAL SCREW & MFG. COMPANY
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Pacific Coast: National Screw & Mfg. Co. of Cal.
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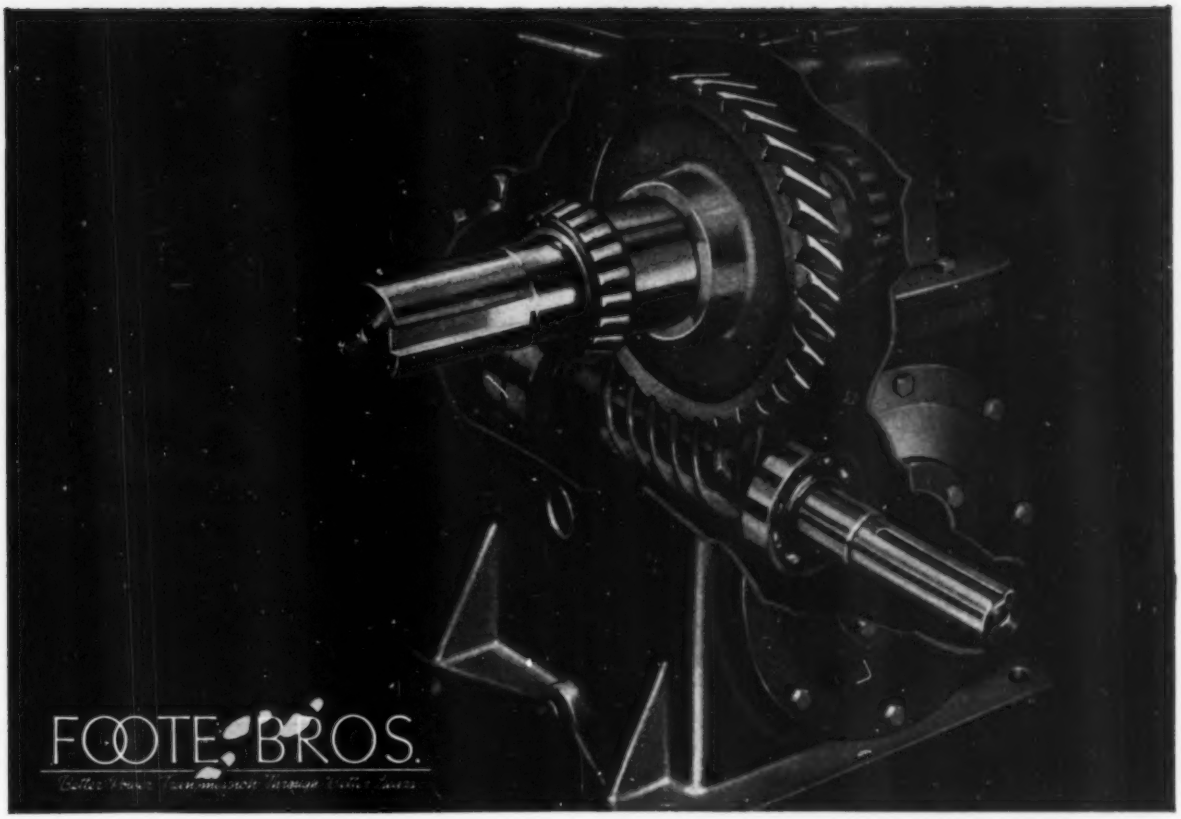
National PRODUCTS

FASTENERS HODELL CHAINS CHESTER HOISTS



a matter of confidence

Specialists who designed this speed reducer entrusted production of its bronze worm gear blank to other specialists.

Foote Bros. Gear and Machine Corporation, Chicago, leading producers of Speed Reducers, Gears, and other quality Power Transmission Components for practically any industrial requirement, identify themselves with the phrase "BETTER POWER TRANSMISSION THROUGH BETTER GEARS."

For over twelve years, Foote Bros. have purchased thousands of ½ pound to 1500 pound non-ferrous gear blanks from National Bearing Division—confidently entrusting their reputation and industry leadership to special foundry skills for which National Bearing is famous.

And Foote Bros. confidence is well placed.

National Bearing's proven ability to mass produce exceptionally fine-grained, non-ferrous castings, free from blow holes and sand inclusions, can be depended upon under even the most exacting engineering and manufacturing specifications.

As a typical customer service-plus, National Bearing Division's engineers and foundrymen recently designed, and produced for customers like Foote Bros., a bronze gear blank that contains even higher physical properties.

Through a new foundry technique, National Bearing imparts greater hardness, finer grain, and more tensile strength to the bronze gear blank ring, to a depth below where the teeth are cut. In addition, this new process gives such extra advantages as higher uniformity, closer tolerances, and economy of stock.

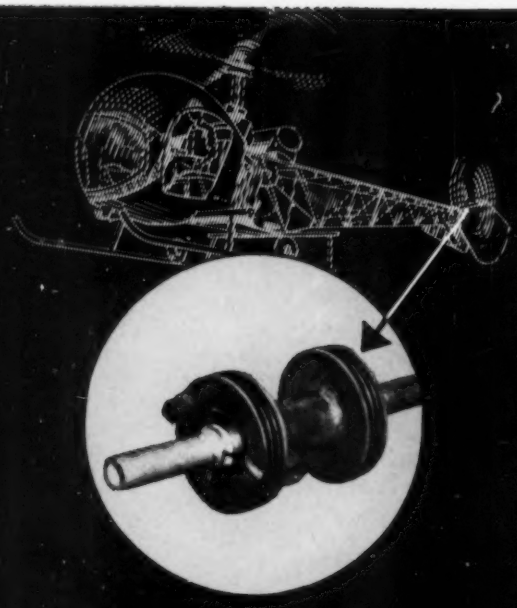
If your product requires special mass-produced non-ferrous castings or bearings, National Bearing Division has the foundry facilities, experience, and skill that will insure better product performance, and may possibly lower product costs through production-run economies. You are invited to write to National Bearing Division for complete information.

AMERICAN **Brake Shoe** COMPANY

NATIONAL BEARING DIVISION

4932 [illegible] • St. [illegible]

PLANTS IN: ST. LOUIS, MO. • MEADVILLE, PA. • NILES, OHIO • PORTSMOUTH, VA. • ST. PAUL, MINN. • CHICAGO, ILL



easier assembly... economical maintenance... with Linear "O" Rings

Linear O Rings perform an unusual job in Bell Aircraft helicopters. The bearing in the tail rotor drive was supported in a metal housing which, because of the metal-to-metal fit, was extremely difficult to install and remove.

By using Linear O rings for mounting the housing, replacement is made easier, maintenance simpler and less costly and a neater, more satisfactory installation is provided.

In many other parts of the helicopter, Linear O Rings provide tight-fitting, space-saving seals.

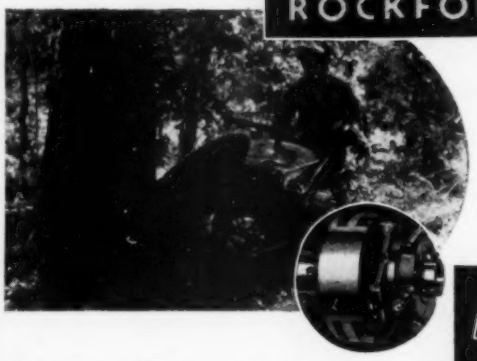
Whenever you need a fool-proof seal, why not consult the Linear Engineering Staff. Write or call Linear today for full information.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., State Rd. & Levick St., Philadelphia 35, Pa.

CLUTCHES by ROCKFORD



This Saw "Mows 'Em Down Even With the Ground"

The LITTLE GIANT Saw cuts down trees and stumps at any angle, bulldozes logs, bores post holes, propels itself anywhere a man can walk and loads itself on a truck. ROCKFORD CLUTCHES control power transmission in this versatile unit. Let ROCKFORD clutch engineers help solve your power transmission control problems.

B-W ENGINEERING MAKES IT WORK

B-W PRODUCTION MAKES IT AVAILABLE

ENGINEERING BULLETIN SENT ON REQUEST

ROCKFORD CLUTCH DIVISION BORG-WARNER
209 Catherine Street, Rockford, Illinois, U. S. A.

Metron

ANTI-BACKLASH

MINIATURE SPEED CHANGERS WITH HOBBED GEARS!

Single-section unit illustrated ¾ ACTUAL SIZE!

ANTI-BACKLASH Metron Miniature Speed Changers are equipped with precision-hobbed, case-hardened steel gears . . . Ideal for use in precision instruments, counting devices, regulators, controls and other equipment requiring high accuracy in small, light weight fixed-ratio speed changing. Anti-backlash is obtained by spring-loading parallel gear trains against each other, so that backlash is taken up continuously. Write for Bulletin No. 100, containing full specifications and prices.

- **STANDARD RATIOS** from 10/9 to 531,441/1.
- **COMPACT!** Only 1.050" diameter; single-section types only 3 1/16" overall!
- **STAINLESS STEEL** ball-bearing drive shafts, permanently lubricated.
- **SPEEDS** up to 10,000 RPM on high-speed shaft!
- **PROMPT DELIVERY** on all Standard Ratios.

METRON INSTRUMENT CO.
444 Lincoln Street **Denver 9, Colorado**
Ask for data on other Metron Miniature Components.

BUILT BY Metron MAKERS OF INSTRUMENTS FOR PRECISION MEASUREMENT

From spindle to spindle—a strong, one-piece forged axle.
Torsion spring engineered to each rated capacity; one end anchored to axle, the other to mounting bracket.
Bracket contains renewable friction bearing insert.

To the designer and builder of towed equipment . . .

Here's the NEW RIDE you've been looking for!

There's just nothing else like it . . . the superior ride made possible by the ASF-Linco "Level-Load" Axle. Here's a completely new principle of axle and springing design . . . *and it accomplishes just what the name implies!*

Keeps the load level—and lower

It can't be any other way. Weight of off-center load is evenly distributed on *both* springs. That—plus the low center of gravity permitted by the axle design—means no tilting or swaying . . . better tracking . . . and an even pull on the drawbar.

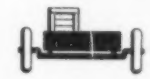
Cushions shocks—adjusts spring tension automatically

Both springs—and both spindle arms—always act together. Spring tension automatically varies itself to meet road conditions and weight of load. Under light loads, spindle arm is horizontal; as load increases, the arm moves up, reducing leverage. The result is higher payload capacity than any other similarly rated axle!

Adds new features to towed equipment

Level, stable riding and tracking of towed equipment—without tilt or sidesway—are features that can help you attract and sell customers. Write for information on towing at its level best! American Steel Foundries, Automotive Division, 410 North Michigan Avenue, Chicago 11.

The first major axle development in 50 years!

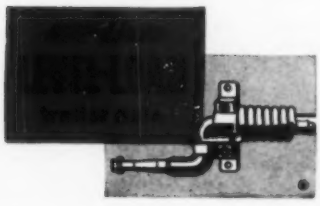


Under load, relative position of axle and body is unchanged. Both springs take load evenly.

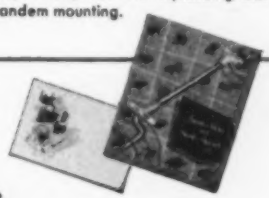
Light load gets full spring action because long leverage absorbs road shocks efficiently.

Full load reduces leverage, which automatically balances the spring to load requirements.

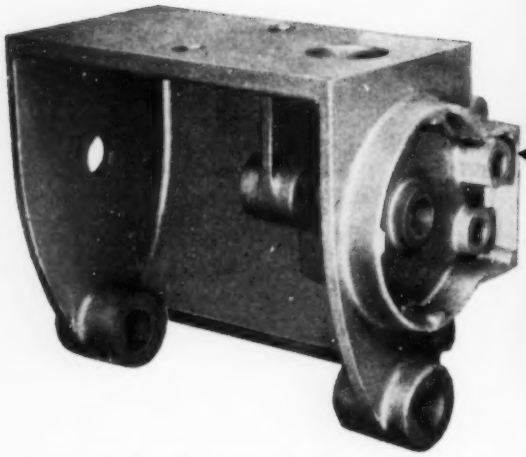
Completely assembled—ready to mount with just 4 bolts! Mount it in minutes to trailer frame, or directly to equipment such as compressors, welding machines, mixers, etc. No equalizing bars needed in tandem mounting.



Be sure to ask for free copies of these booklets . . .



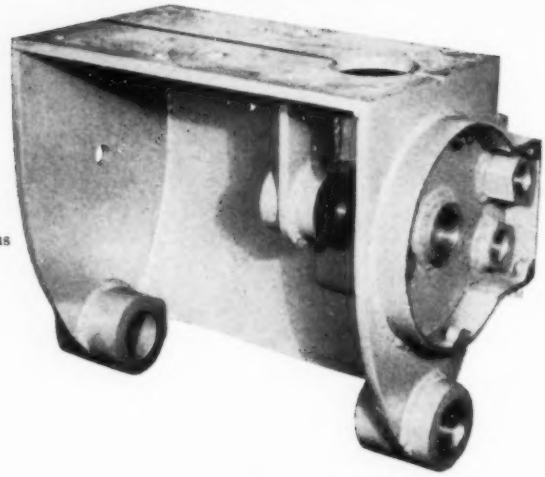
AMERICAN STEEL FOUNDRIES



Gearbox for power-driven saw, as cast in Gray Iron.

45% SAVED...
on original cost of part

41% SAVED...
on machine and labor expense



Fabricated gearbox, which was replaced by the cast design.

By redesigning in Gray Iron, it is often possible to effect substantial cost savings. Here is a striking example:

> The manufacturer of a large power-driven metal saw found that the cost of a fabricated gearbox (right above) was out of line from a competitive standpoint. Designs for a suitable Gray Iron casting were requested and approved. Result:—the Gray Iron casting is effecting a saving of 45% on original cost of the part, plus a saving of 41% on machine and labor expense.

Doesn't this suggest that it's time to analyze *your* costs on certain fabricated parts—with a view to producing them better and more economically in Gray Iron? Write for technical information on the many advantages of the Gray Iron casting process.

GRAY IRON Characteristics Include:

- Castability
- Rigidity
- Low Notch Sensitivity
- Wear Resistance
- Heat Resistance
- Corrosion Resistance
- Durability
- Vibration Absorption
- Machinability
- Wide Strength Range

Make it Better with Gray Iron • **Second largest industry in the Metal-working field**

GRAY IRON FOUNDERS' SOCIETY, INC.
NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

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  - Allison Division—General Motors Corp.
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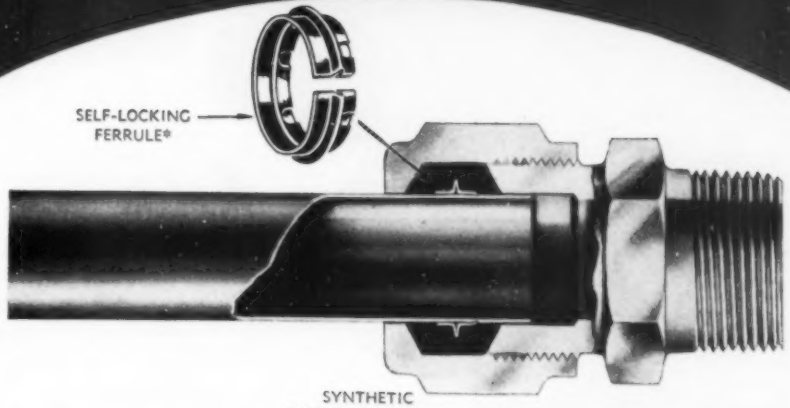
  - Howe Ice Machine Company

THESE NOTABLE NAMES IN AMERICAN INDUSTRY DEPEND ON . . .

Sealastic

ALL-PURPOSE FITTINGS



THE FITTING THAT IS SHOCK ABSORBING AND VIBRATION-FATIGUE PROOF FOR LOW, MEDIUM AND HIGH PRESSURES

By eliminating metal-to-metal contact between tube and fitting, SEALASTIC ends your problem of leaks and breaks caused by shock and vibration-fatigue. Overcomes tube misalignments. Permits dependable, cost-saving, straight-line-tubing between fixed points.

This cushioned-coupling design provides a seal ring of synthetic rubber, surrounding a ferrule (either self-locking or solid ring swaged, sweated or brazed).

Seal ring prevents metal-to-metal contact and cushions against vibration. Nut only needs to be tightened by hand to place entire seal under compression (to withstand pressure up to 4,000 p.s.i.).

Substantial time and labor savings in assembly work or emergency repairs are made possible because Sealastic Fittings are engineered and integrated to your special requirements.

The varied industries listed at the left are proof of Sealastic's practical application wherever fuel, oil, water, refrigerants, air or ether injection must pass through metal tubes or piping.

May we send you descriptive booklet and full details of Sealastic engineering service?

*For critical applications, we recommend the solid ferrule fixed on the tube.

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A simple problem for the rubber technologist, you may say. But it's significant that Tektronix, Inc.—of Portland—had Roth Rubber—in Chicago—provide the solution to this one:

Designed for television broadcasters and research laboratories, the Tektronix 524-D Oscilloscope provides the engineer with a close-up of any line or portion of the picture, enabling him to make a fine determination. This wonderful electronic instrument depends, for its viewing efficiency, on a simple, inexpensive viewing hood supplied by Roth.

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Please comment on attached description of our rubber problem or production rubber requirements.

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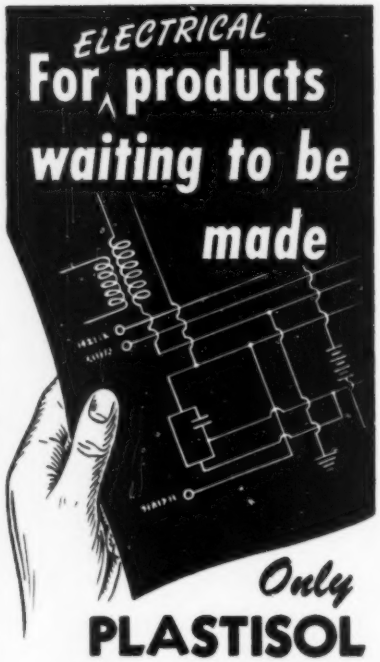

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PLASTISOL INSULATION
for Molding, Extruding or Dipping can be specifically compounded to produce these advantages:

- Ease of molding or coating—inexpensive molds or equipment required
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- Low temperature flexibility
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- Resists most acids and alkalis
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Whatever you manufacture, from spaghetti wiring to circuit-breaker panels, Stanley chemists can formulate a vinyl plastisol to meet your most exacting insulation requirements. For specific information write *today* to the Stanley Chemical Co., 82 Berlin St., East Berlin, Conn.

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3. Saves on manufacturing costs
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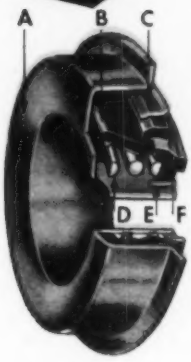
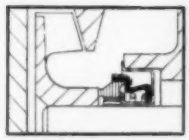




A. Seal Retainer.
B. Synthetic Rubber Bellows.
C. Metal Band.
D. Spring.
E. Holding Dents.
F. Precision-Lapped Sealing Washer.

STATIONARY SEALING HEAD TYPE 11-A

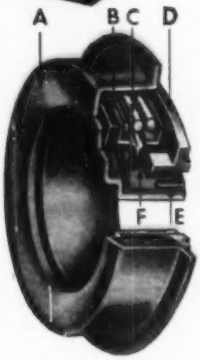
This pressed-in packaged sealing unit is designed to protect the spiral steel spring inside of the synthetic rubber bellows against corrosion.

The spring clamps the flange of the bellows tight against the bottom of retainer and the metal ferrule squeezes the top portion of the bellows against the "Teeplelite" washer.

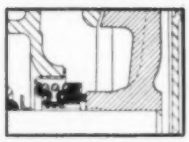
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Low Pressures* 35 PSI
Low Temperatures −65°F. to 220°F.

LOW COST



STATIONARY SEALING HEAD TYPE 6-A



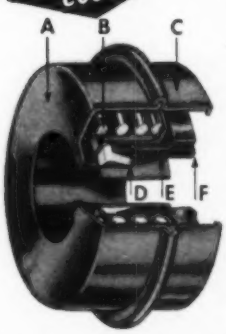
A. Seal Retainer.
B. Metal Ferrules.
C. Spring.
D. Precision-Lapped Sealing Washer.
E. Holding Dents.
F. Synthetic Rubber Bellows.

This pressed-in packaged sealing unit is designed with a spiral steel cadmium plated spring (stainless or bronze optional) assembled between two metal ferrules which clamp the flanges of the synthetic rubber bellows tightly against the retainer shell and the "Teeplelite" washer.

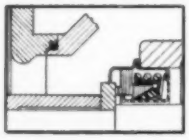
This liquid-tight seal is especially recommended for small shafts on *hot or cold water, oil, gasoline, kerosene, soapy water.*

Use this seal on: *Medium Pressures* 75 PSI
Low Temperatures −65°F. to 220°F.

LOW COST



STATIONARY SEALING HEAD TYPE 9-A



A. Seal Retainer.
B. Spring.
C. Sleeve.
D. Wedge of Teflon.
E. Sealing Washer.
F. Precision-Lapped Face.

This pressed-in packaged sealing unit is designed to use a wedge sealing ring of Teflon*. This wedge shaped sealing ring closely fits the inner sleeve of the retainer and makes a liquid-tight contact with cone surface of carbon washer.

The result is a liquid-tight seal which is especially recommended for *hot oil, and all chemical liquids or gases, hot or cold.*

Use this seal on: *High Pressures* 200 PSI
High Temperatures 350°F. *Low Temperatures* −100°F.

Crane Packing Company, 1845 W. Cuyler Ave., Chicago 13, Ill.

*Du Pont Trade-mark for tetrafluoroethylene resin

1. **Compact new packaged units.**
2. **Stationary sealing head, pressed-in type.**
3. **½" clearance around shaft, ¼, ⅜, ½, 1" diameter.**
4. **No vibration.**
5. **Easy to install, easy to replace.**
6. **Liquid-tight.**
7. **Minimum friction, cool running.**
8. **Minimum wear, rubbing.**
9. **Great flexibility.**
10. **Inspected parts.**
11. **Tested.**
12. **Closer bearings.**
13. **Shorter shafts.**
14. **No shaft deflection.**
15. **No run-out.**
16. **High speed.**

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Continental made this improvement possible because it was able to develop a rubber compound that withstands the sustained heat generated by the electrical heating element. Continental also solved the equally difficult problem of positioning this heating element so that it would not shift and "short" itself when the pad was molded.

The success of this development is another example of the specialized assistance in rubber which Continental offers to design and production engineers.

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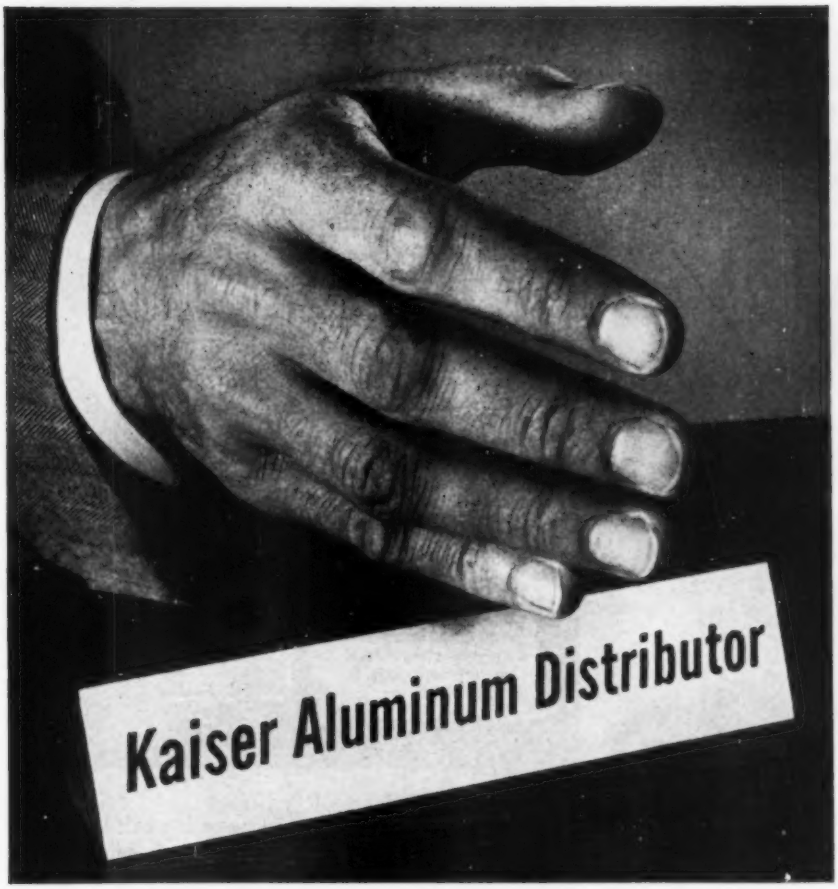

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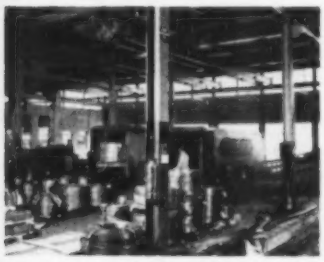
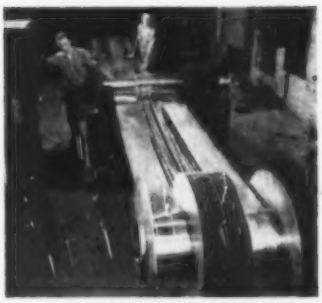


LOWER COSTS—Specialization of warehouse plant and handling equipment permits deliveries at lower cost at machine side, cuts stock keeping and accounting costs.



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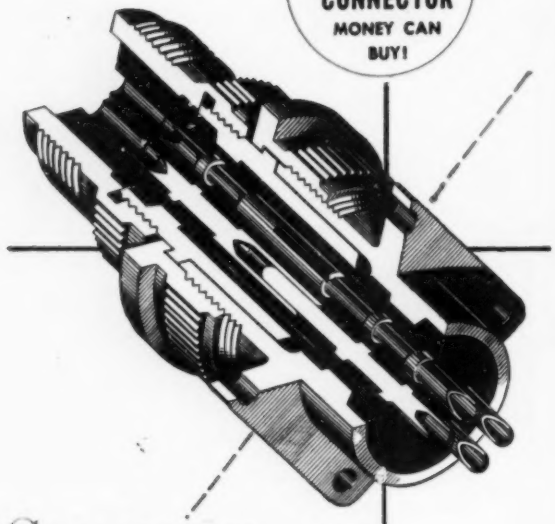

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Base machined for socket-head installation and adjustment. All measurements held to specifications.

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The resulting Mac-it screw met all specifications exactly — typical of all Mac-it products. When you need special screws, call or write your nearest Mac-it distributor or the Main Office, Cleveland, Ohio.

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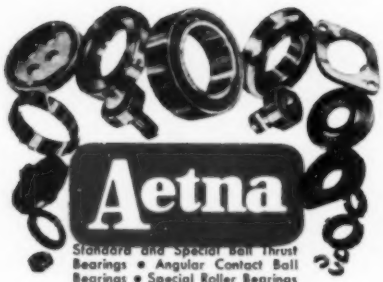
As an executive it may pay you handsomely to find out what Aetna products can do to help make your product more useful, easier to sell, or cheaper to make. A letter, wire or 'phone call will place our engineers at your disposal.



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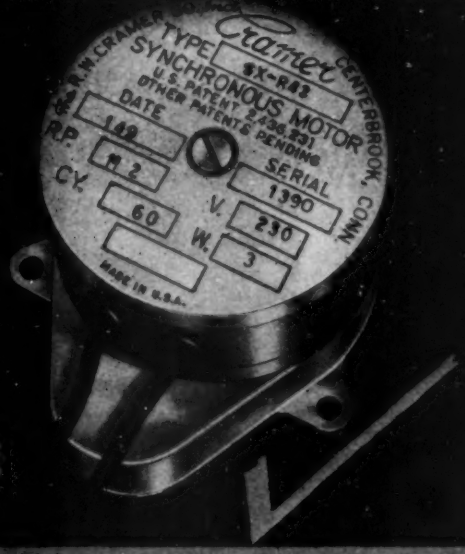
SYNCHRONOUS TIMING MOTOR

GIVES YOU UP TO 5 TIMES THE TORQUE



This "mighty midget" SX motor provides the power for a wide variety of timing devices, recording instruments, signal systems, traffic controls, and other similar control devices that require dependable performance at constant speed. Available in many output speeds ranging from one revolution per second to one revolution per day, the SX *provides up to five times the power of most hysteresis clock motors of equivalent size.*

Write for Cramer Timing Device Catalog or specify Bulletin No. 10A for complete information on the Model SX Motor.

Check THESE OUTSTANDING FEATURES

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- **Instantaneous Response** . . . to synchronous speed within 2 cycles of applied voltage; dead stop within 1 cycle.
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- **Runs Equally Well in Any Position.**
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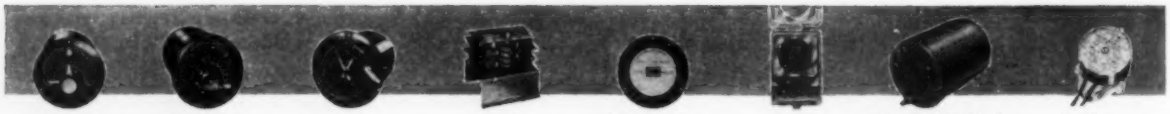

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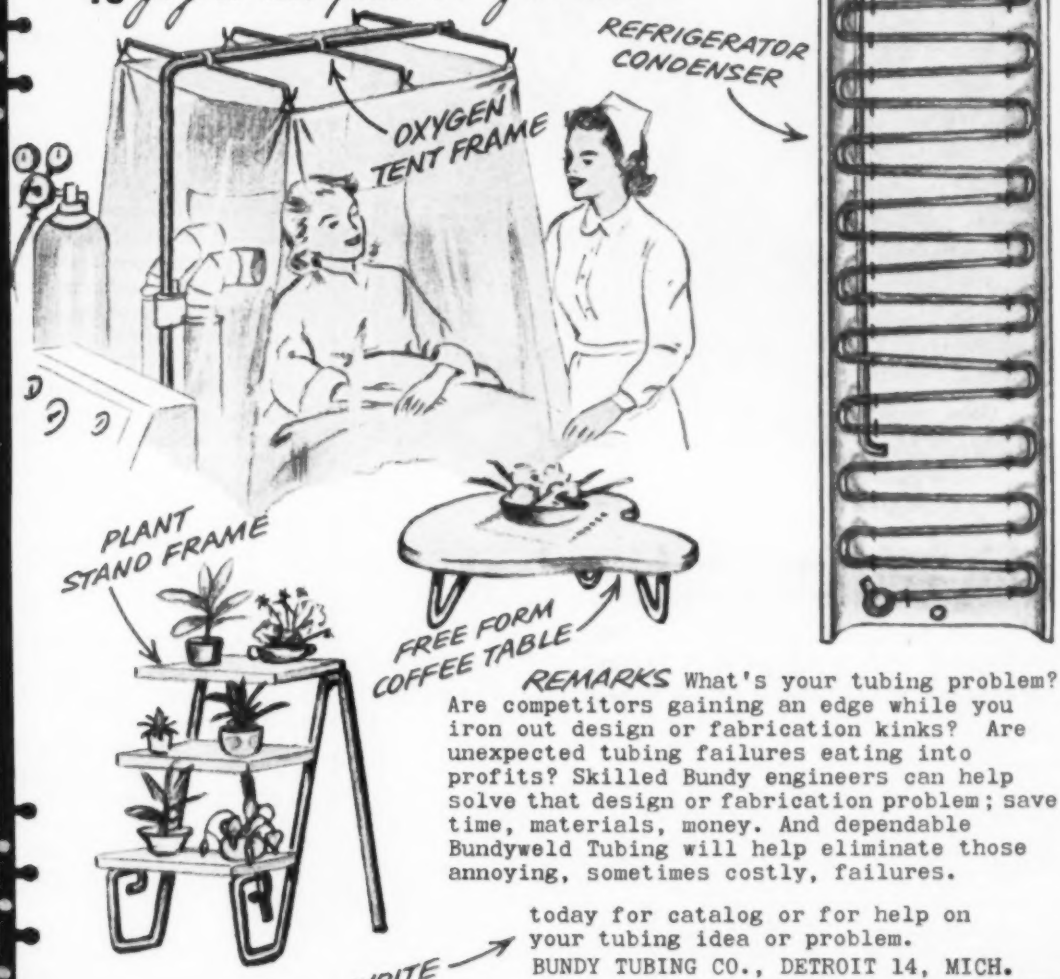
TO *jog a designer's imagination*



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® DOUBLE-WALLED FROM A SINGLE STRIP

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Machines easily
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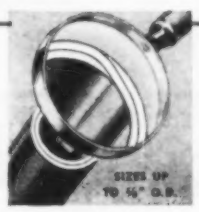
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . . continuously rolled twice around laterally into a tube of uniform thickness, and passed through a furnace. Copper coating fuses with steel. Result . . . Bundyweld, double-walled and brazed through 360° of wall contact.



← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: *Cambridge 42, Mass.:* Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

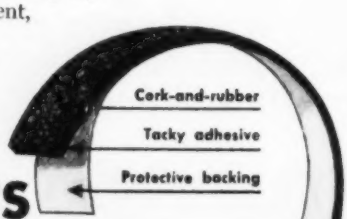
This cork-and-rubber tape stops shocks as well as leaks

Used as a die-cut gasket between the glass face and cast metal housing of parking meters, Armstrong's DK-153 Tape keeps rain and dust out—and prevents glass breakage.

DK-153 is a resilient cork-and-rubber material with a pressure-sensitive adhesive backing that makes it easy to apply. All you do is peel off the cloth backing and press the tape into place. It sticks instantly to any clean, dry surface.

This versatile tape is widely used to cushion breakable parts in shipping. It also makes an ideal anti-squeak and anti-skid material.

DK-153 Tape comes in a variety of widths and thicknesses in sheets, rolls, or die-cut shapes. For samples, write on your letterhead to Armstrong Cork Company, Gaskets and Packings Department, 6804 Arch Street, Lancaster, Penna. Available for export.



ARMSTRONG'S DK-153 TAPE

Exactly how do the new synthetics compare with natural rubber?

A brief report in your *Annual HANDBOOK of Product Design for 1953* gives you the important properties of seven synthetic polymers as compared to natural rubber. In addition, the chemical and physical properties of four synthetics, along with natural rubber, are rated Poor-to-Excellent in convenient chart form.

This data, and hundreds of pages of significant design-engineering information in your *HANDBOOK for 1953*, is being utilized profitably every day by design engineers. Be sure to consult your *HANDBOOK* for help in finding the right answers to many problems facing you in your job.

The *HANDBOOK* is completely indexed and sectionalized into ten major subject classifications, enabling you to find exactly the information you want quickly. The two-page report mentioned above, "Properties of *Natural* and *Synthetic* Rubbers," for example, is located in the third section, *Non-Metallic Materials and Finishes*.

Take advantage of the wealth of permanently useful data in your *HANDBOOK*. You will receive another volume, *The Annual HANDBOOK of Product Design for 1954*, in Mid-November. It will be a worthy companion-addition to your '53 *HANDBOOK*, with an even broader and more penetrating coverage of your interests.

Product Engineering

330 West 42nd Street
New York 36, N. Y.

SAFEGUARDING INDUSTRY'S *Lifelines of Mobile Power*

190 HORSEPOWER "led to work" through

Eastman

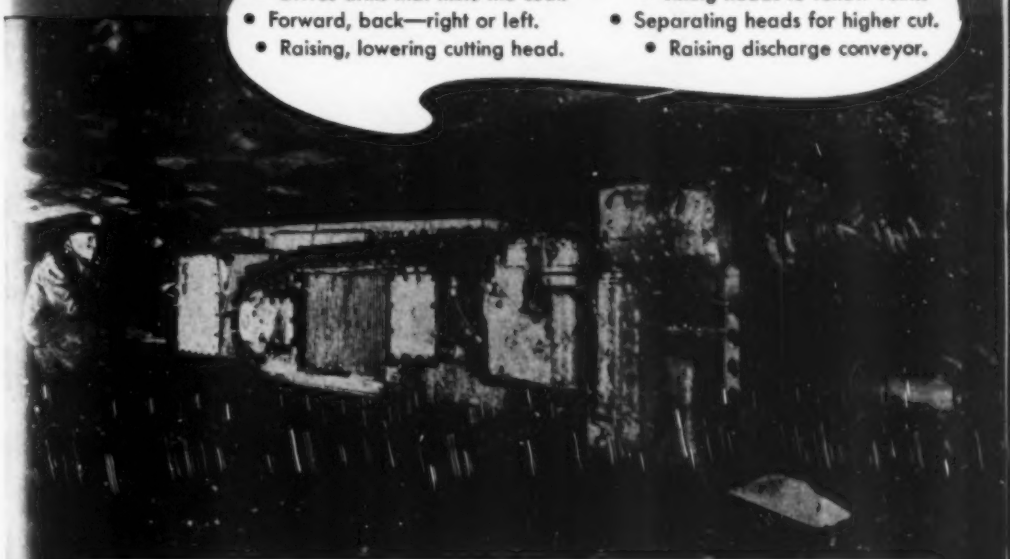
first in the field

HYDRAULIC HOSE ASSEMBLIES

enables the Jeffrey COLMOL to mine 3 to 5 tons of coal per minute

Every movement and adjustment performed hydraulically

- Drives arms that mine the coal.
- Forward, back—right or left.
- Raising, lowering cutting head.
- Tilting heads to follow veins.
- Separating heads for higher cut.
- Raising discharge conveyor.



The mechanical marvel shown in operation here . . . the 76-B Jeffrey COLMOL . . . is indeed a "mighty mole," capable of tunneling into a coal vein at a speed of two feet, or more, per minute—delivering from 50 to 100 tons of coal per man day.

Every movement and adjustment is hydraulically controlled through Eastman Hydraulic Hose Assemblies. Over 2000 psi is applied through 1¼" Eastman double braided hose, delivering 140 hp to 10 coal cutters which rotate at 50 rpm against the coal seam. Another 50 hp is independently provided for other hydraulic operations. Marvelous mobility is evidenced by the fact that this 25 foot, 35 ton monster can turn around in its own length.

The Jeffrey Mfg. Co., pioneers in the coal mining equipment field, have used Eastman Hydraulic Hose Assemblies on all their machines for over 20 years. Eastman Manufacturing Company, pioneer in its own field, too—is proud to have played a part in the development of the Jeffrey line.

Call upon our 25 years of experience in the application of mobile hydraulic power . . . for greater efficiency in power transmission, lowest cost power delivery and most satisfactory performance. Engineering consultation at your call.

Specify

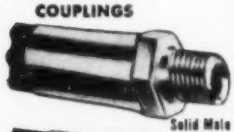
Eastman

first in the field

HYDRAULIC HOSE ASSEMBLIES

for the best performance, for long life and satisfaction—*all along the line*—from manufacturer to user. Check your needs on the following list:

COUPLINGS

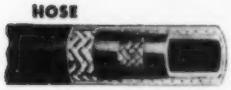


Solid Male

Swivel Male

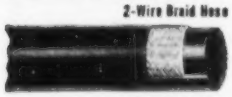
Swivel Female

HOSE



1-Wire Braid Hose

2-Wire Braid Hose



1-Fabric Braid Hose

2-Fabric Braid Hose

Spiral Wire Hose

Write

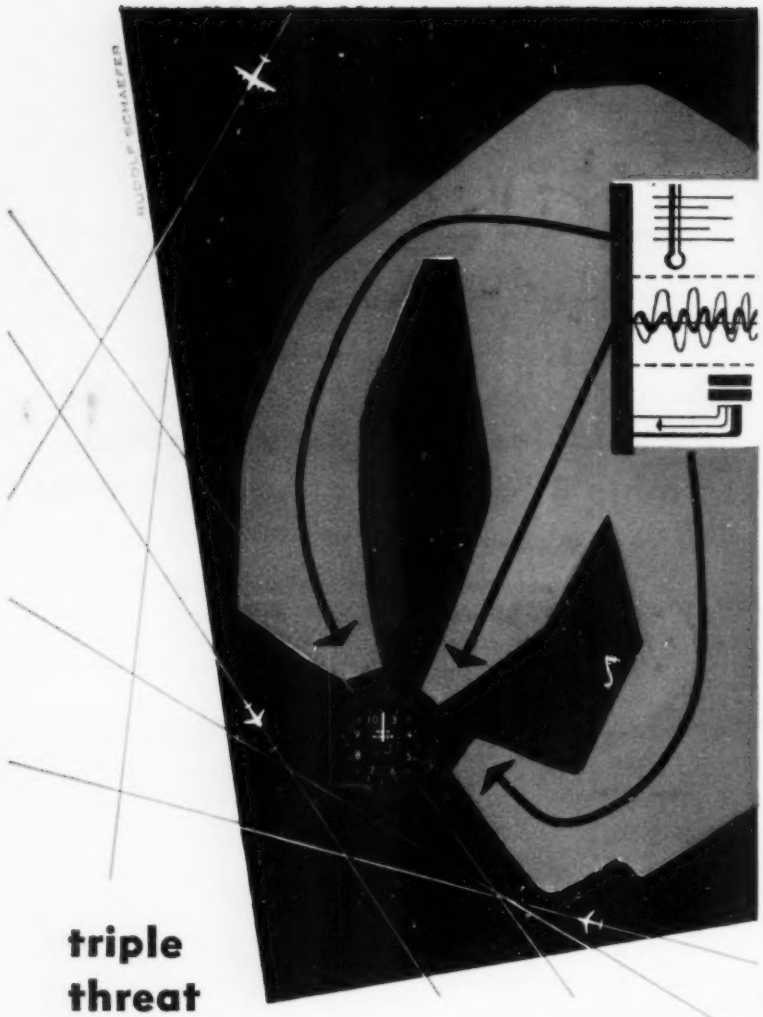
for free catalog 101 on Eastman hose couplings and fittings.

Eastman

MANUFACTURING COMPANY

Since 1914

Dept. PE-4, Manitowoc, Wisconsin



triple threat

Changing temperatures, vibrations, and accelerations affect the operation of all instruments. In spite of these variables, our products produce the right answers because they are properly designed.

- AIRCRAFT INSTRUMENTS AND CONTROLS
- OPTICAL PARTS AND DEVICES
- MINIATURE AC MOTORS
- RADIO COMMUNICATIONS AND NAVIGATION EQUIPMENT

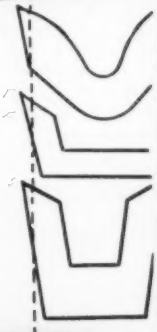
Current production is largely destined for our defense forces; but our research facilities, our skills and talents, are available to scientists seeking solutions to instrumentation and control problems.

kollsman INSTRUMENT CORP.

ELMHURST, NEW YORK • GLENDALE, CALIFORNIA • SUBSIDIARY OF Standard COIL PRODUCTS CO., INC.

The Superiority of Periflex Packings begins with Mold Engineering!

IT'S THE LIP TAPER

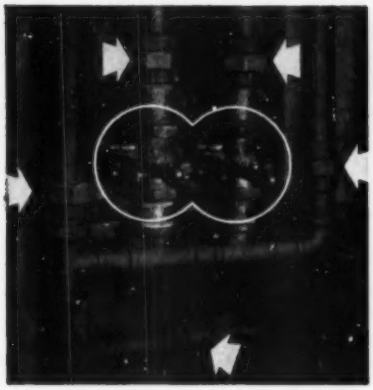


Let us send our new catalog listing mold data.

Sufficient interference to produce an efficient seal and at the same time minimum frictional drag on moving surfaces has been accomplished by Periflex. Careful attention is given in our shop to maintain close tolerances and special design features in mold manufacture.

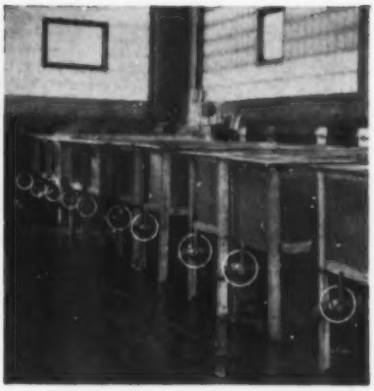
Periflex Inc.

HAZEL PARK • MICHIGAN



Revere Copper and Brass Co. Application: On quenching lines bringing unfiltered river water to annealing furnace at 100 psi — operated 60 times daily. *Report: Rockwood Ball Valves have lasted four times longer than any other valve.*

Iroquois China Co. Application: Handling a clay and water mixture — operated 40 times daily. *Report: Each Rockwood Ball Valve has performed better, operated easier and lasted longer than any other valve this company has ever used.*



Daggett Chocolate Co. Application: On processing tanks for syrups and cherries — operated constantly. *Report: Rockwood Ball Valves keep tanks in service longer . . . have been on lines two years with no maintenance at all.*

Here's more proof that

no other valve performs so well . . . lasts so long . . . saves so much

4 BIG FEATURES FOR TOP PERFORMANCE

Full Round Flow . . . no change in shape or volume of the fluid stream . . . no turbulence . . . minimum friction loss.

Quick Opening and Closing . . . needs only a quarter turn, even under full pressure.

Resists Wear Longer . . . scratching, pitting and abrasion have little effect on the chrome-plated, floating bronze ball.

Stays Leakproof . . . in closed position, pressure of fluid automatically positions ball against synthetic rubber seat to form a tight seal.

TESTED BY UNDERWRITERS' LABORATORIES, INC.

Get the whole story of how this outstanding Rockwood development gives you more of what you want in valve performance. Mail the coupon today.

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ROCKWOOD *FULL-FLOW* BALL VALVES

THE FLOW IS AS ROUND AS THE PIPE ITSELF

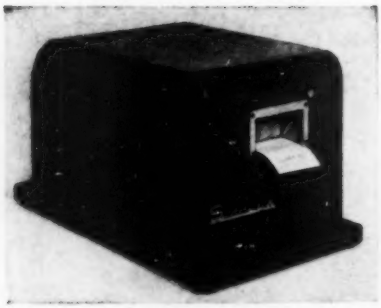
ROCKWOOD

ROCKWOOD SPRINKLER COMPANY
106 Harlow St., Worcester 5, Mass.

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves

Name .....
Title .....
Company .....
Street .....
City .....
Zone ..... State .....

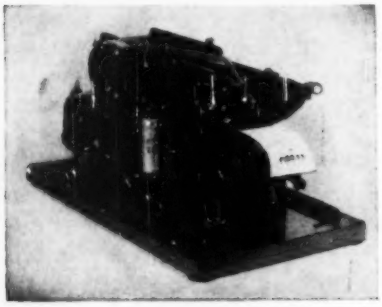
Do you *need a motor* with a maximum of dependability and life expectancy?

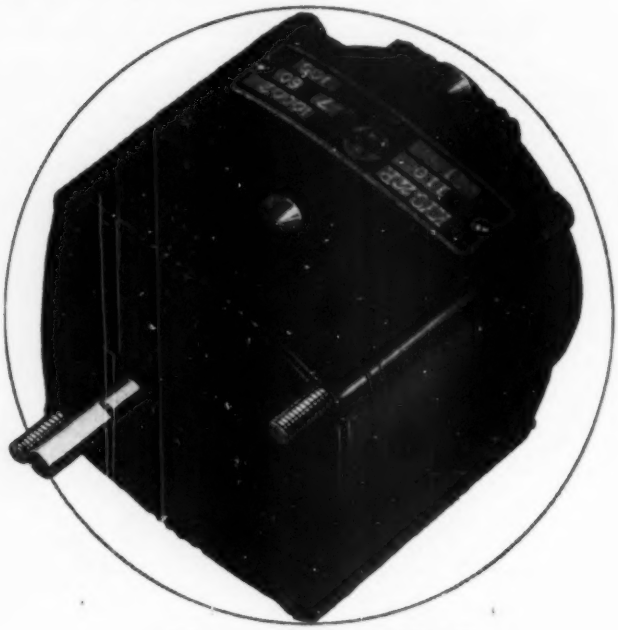


Simplex

PRINTING TIMER

An electrically operated printing stop watch for industrial and scientific timing applications. It provides a practical means of obtaining experimental or production time data automatically through remote controls.





BODINE

has a broad line of motors that meet these requirements

The Simplex Time Recorder Co. of Gardner, Massachusetts, met their requirements by selecting Bodine motors. They had this to say: *"In laboratory tests, our engineering department found that the Bodine motor had the highest torque and performed the best of any motor we tried. We have been manufacturing precision timing instruments since 1888 and it is essential that we have a motor unit with a maximum of dependability and life expectancy. The Bodine motor provided us with a small motor to give us long periods of operation with no maintenance, and compactness of design."*

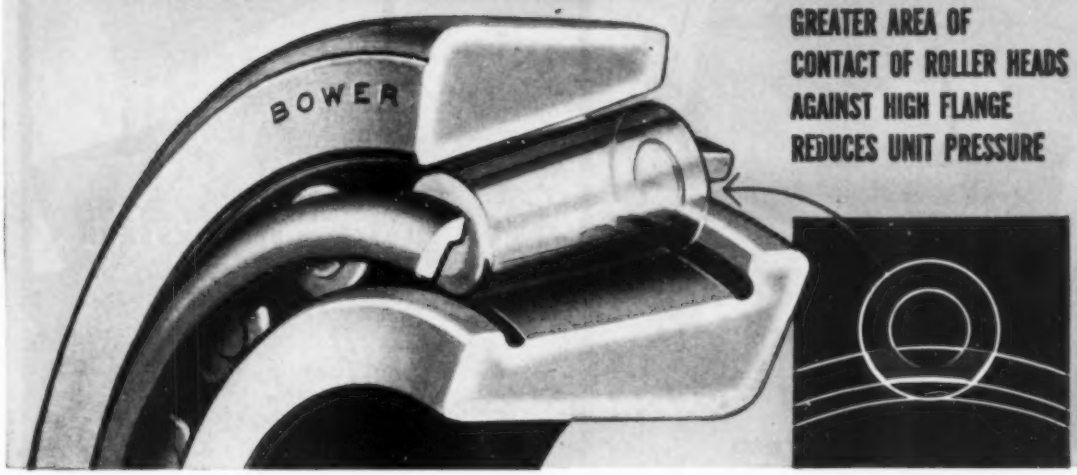
Bodine has over 3,500 different standard types, sizes, and windings of fractional horsepower motors from 1/2000 to 1/6 horsepower. Unexcelled in performance and reliability, Bodine motors will contribute to the design superiority of your motorized products. Specify Bodine, today.

Bodine Electric Co., 2260 W. Ohio Street, Chicago 12, Illinois

REPRESENTATIVES IN PRINCIPAL CITIES. IN CANADA: RENOLD-COVENTRY, LTD.

BODINE MOTORS...THE POWER BEHIND THE LEADING PRODUCTS

Bower spher-o-honed design increases bearing life



Bower engineers have incorporated many basic refinements into the design of Bower tapered roller bearings which cut maintenance to a bare minimum—increase efficiency. One of the most important of these is the *exclusive* feature illustrated above. Note that the flange at the large end of the cone is *higher*—providing a greater contact area for the roller heads. This greatly reduces wear, improves roller alignment and minimizes resultant "end play". Also note the larger oil groove, providing positive lubrication to the roller heads.

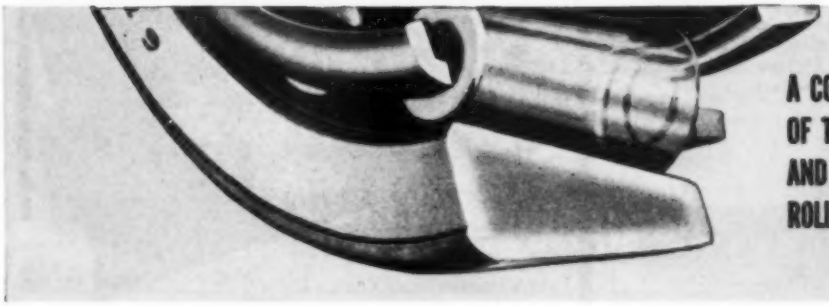
Other important Bower features which increase bearing life and dependability are generated spherical roll-heads, and smooth, precision-honed races. And Bower bearings are known throughout industry for materials and workmanship of highest quality.

Whether your product is in full production or still in the planning stage, you'll be wise to call in a Bower engineer now. He'll show you a wide range of sizes and types to fit any application.

BOWER ROLLER BEARING COMPANY • DETROIT 14, MICHIGAN

BOWER
ROLLER BEARINGS

SPHER-O-HONED



A COMPLETE LINE
OF TAPERED, STRAIGHT
AND JOURNAL
ROLLER BEARINGS

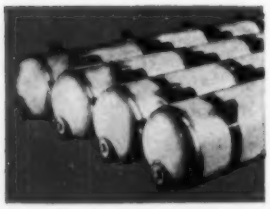
containers to fit the picture . . .

a specialty at **SCAIFE**

If containers are a component part of the equipment you're building or using, you'll find Scaife Company engineering skill and ingenuity can provide the answers to a lot of design problems.

Take one Scaife customer as an example . . . railroad car builders have called on Scaife to build Air Pressure Water Tanks that store the water used in galleys and washrooms of dining and sleeping cars. They know that Scaife is well-fitted, by a century and one-half of broad experience in the pressure vessel field, to develop exactly the right tanks for this kind of specialized service.

Why don't you join the increasing number of up-to-date builders who count on Scaife Company for help when repeat specifications call for containers with strength, lightness, durability and dependability.



120-gallon alloy water tanks for use on railroad passenger cars.

FOUNDED 1801

SCAIFE COMPANY

OAKMONT (Pittsburgh District) PA.

Makers of Pressure Vessels and Drawn Shapes

allwood* hardboard builds for profit

cabinets, displays, furniture, shipping containers, storage bins, TV and radio sets, toys, tool boxes...more and more products are being built with Allwood ...and with profit. As a designer and engineer, you'll find this dependable Douglas fir hardboard readily adaptable to your product, plant, or plans. Discover how Allwood can build for you. Just ask Simpson Logging Co., Seattle, Wash., national sales agents for Allwood hardboard. TECHNICAL BOOKLETS ARE FREE.

OREGON LUMBER COMPANY

BAKER, OREGON

*Trademark Oregon Lumber Co.

NEW

small size

marion

2½"

ELAPSED TIME INDICATOR

HM2ET (2½")

HM3ET (3½")

small panel size — standard 2½" JAN dimensions

reduced weight and cube

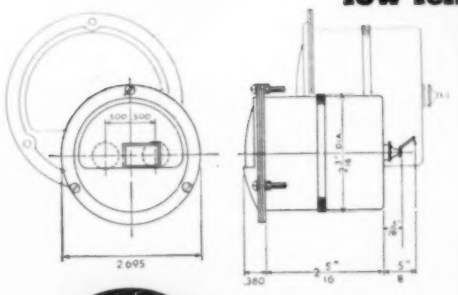
wide operating temperature range −55°C to +85°C

low temperature (−55°C) starting and operation

hermetically sealed — true glass-to-metal

tamperproof

easy to read — standard size counter



SPECIFICATIONS	
Registers: 1/10 hour steps to 9999.9	Registers: 1 hour steps to 99999
Drawn steel case — magnetically shielded	
Self-starting Synchronous Motor	110-125 or 220-250 volt 50 or 60 cycle A.C.

Write for further information
Marion Electrical Instrument Company, 415 Canal St., Manchester, N. H., U.S.A.

marion meters

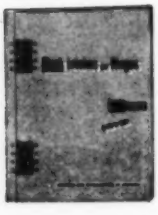
Reg. U.S. Pat. Off.

MANUFACTURERS OF RUGGEDIZED AND "REGULAR" METERS AND RELATED PRODUCTS

Hartwell Flush Latches

300 available for over COMBINATIONS of door and frame thicknesses

Hartwell Trigger-action Flush Latches are produced in over 300 stock combinations of bolt and trigger offsets. We can supply a latch for any door of any thickness to be latched in a frame of any thickness to your specifications. No altering of panels and frames is necessary when Hartwell Flush Latches are installed. Offset. of bolt and trigger are stamped on each part for rapid and accurate selection of the correct latch for each installation.
All Hartwell Flush Latches and Hinges are the result of over a decade of continuous specialized design and manufacture.



Write for new Flush Latch and Hinge Catalog.

HARTWELL COMPANY
9035 VENICE BOULEVARD,
LOS ANGELES 34, CALIFORNIA

REFRIGERATOR RAIDS WITH NO SCRAPES, SCUFFS or SCRATCHES

RIGID-*tex* METALS
FOR MAR-RESISTANT TRIM

wherever scuffs, dents and even fingerprints appear on refrigerator surfaces, there's a need for design-strengthened Rigid-tex Metal. scuff plates, door trim, shelf guards and many other hard-use areas can have **lasting** beauty that's filled with eye-catching sales appeal.
write for Design Imagineering Folder . . . on company letterheads, please.

RIGID-tex METALS
RIGIDIZED METALS CORPORATION
6734 OHIO STREET BUFFALO 3, N. Y.

50 Warehouses and Sales Representatives in All Principal Cities Throughout the U. S. and Canada

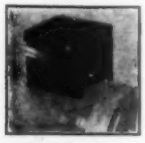
U. S. & Foreign Patents

Pattern 2-DD

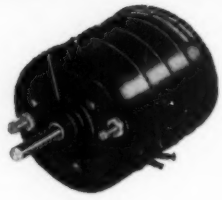
HEINZE
SUB-FRACTIONAL HORSE POWER MOTORS

Ventilated case

Flat strap mounting bracket



Junction box welded to case



Type D

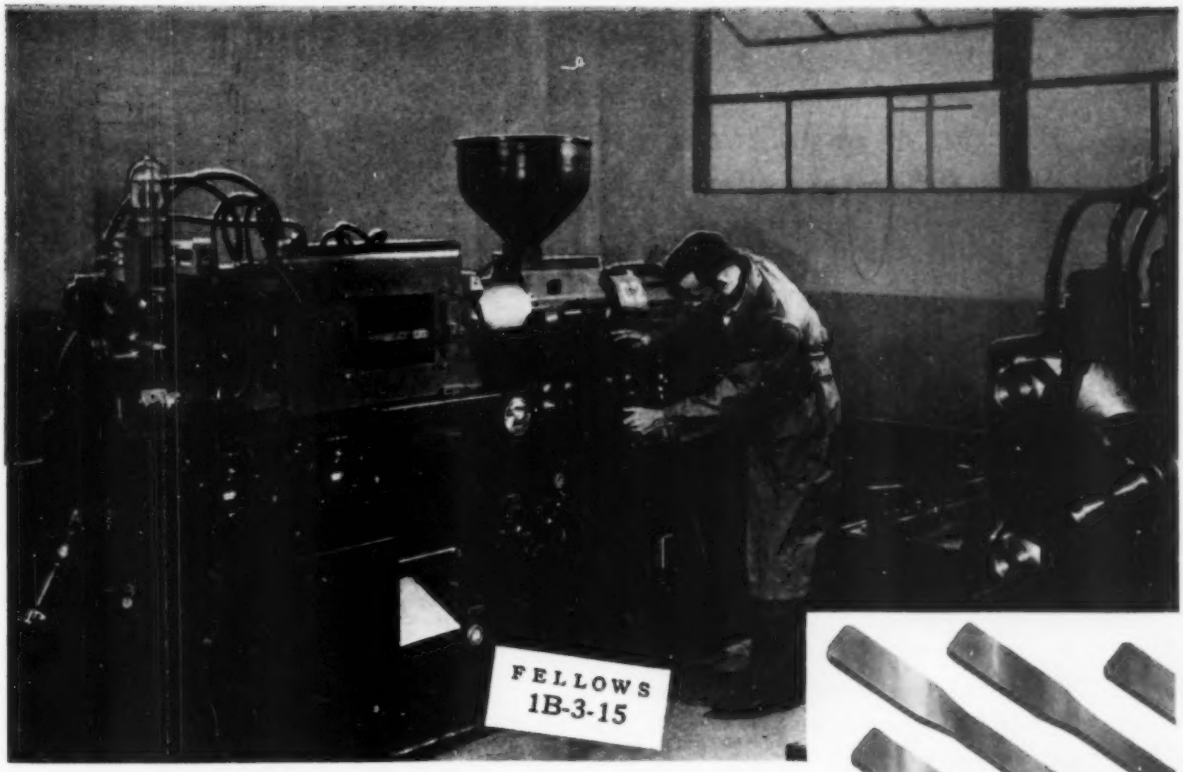
2 pole, shaded pole motor. A rugged, simple and dependable little unit which will operate for years with a minimum of attention.

For pumps, fans, advertising displays, brooders, space heaters, etc.

Normally supplied for 115 v. 60 cycle operation in either C. W. or C. C. W. rotation but can be furnished for other voltages or 50 cycle operation on special orders.

The complete line of Heinze Motors and Blowers is shown in the Heinze catalog.

Heinze Electric Co.
685 Lawrence Street
LOWELL, MASS



In the Lab...OR on the Line
Quality Control means More Profit

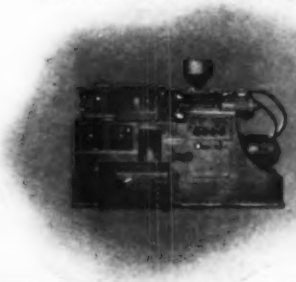
That's why a leading producer of basic plastics selected this Standard Fellows 1B-3-15

The molding of tensile test bars is a vital first step in the maintenance of quality control. Complete dependability and consistent molding machine performance is essential. Accurate control of time, temperature, pressure and other variables must be established beyond question.

The selection of Fellows 1B-3-15's (a production line model) for this exacting job shows the kind of performance you can expect.

To easy and economical handling, and the profit-making production speeds of Fellows Injection Molding Machines you can add their flexibility on the production line.

We suggest your personal investigation and examination. Call us now. See addresses below.



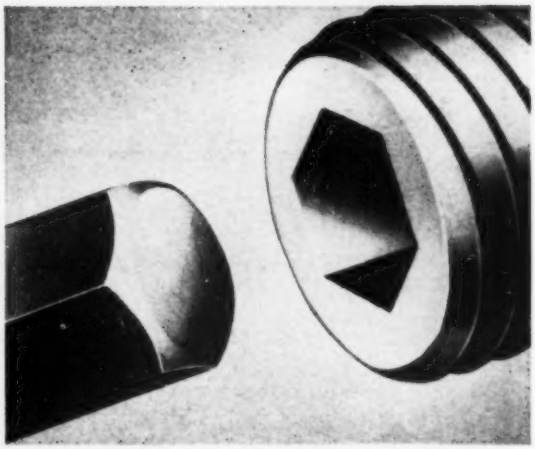
Fellows
injection molding equipment

THE FELLOWS GEAR SHAPER COMPANY, Plastics Machine Division, Head Office and Export Department, Springfield, Vermont
Branch Offices: 323 Fisher Bldg., Detroit 2, Michigan • 5835 West North Avenue, Chicago 39, Illinois • 2206 Empire State Bldg., New York 1, N. Y.

BRISTOL'S HEX SOCKET SCREWS

Meet every requirement of DESIGN, PRODUCTION, *and* MAINTENANCE

Bristol makes a complete line of socket screw products in sizes from 0 wire to 1 in. in diameter. Standard and listed sizes are stocked in heat-treated alloy steel. Brass, bronze, monel, stainless steel, etc.; are furnished on special order. All Bristol screws are carefully designed to close tolerances (A.S.A. approved, Class 3 fit) and precision-threaded either National Coarse or National Fine.



HERE'S WHAT BRISTOL'S HEX SOCKET SCREW DOES FOR

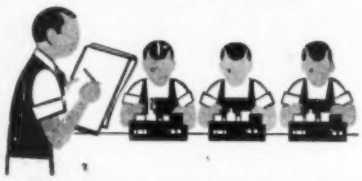
THE DESIGN ENGINEER

- ✔ withstands shock
- ✔ gives neater, more streamlined appearance
- ✔ provides stronger fastening
- ✔ permits more compact design
- ✔ withstands vibration

THE PRODUCTION ENGINEER

all of the above, *plus*...

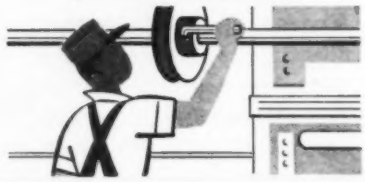
- ✔ saves time
- ✔ provides faster and easier assembly
- ✔ makes for less rejects
- ✔ prevents wrenches from slipping and marring surfaces



THE MAINTENANCE MAN

all of the above, *plus*...

- ✔ provides easy disassembly
- ✔ makes for greater safety



Write for free bulletins showing applications. Only Bristol makes *both* Multiple-Spline and Hex... for severe and regular service.

SET SCREW | FLAT HEAD CAP SCREW | CAP SCREW | SHOULDER SCREW | PIPE PLUG

BRISTOL'S SOCKET SCREWS

Multiple-Spline and Hex Socket Screws. Cap and Set

THE BRISTOL COMPANY, Socket Screw Division, Waterbury 20, Connecticut

A.3.1A

Webster Pumps give a real "LIFT" to Massey-Harris Tractors!

Massey-Harris Diesel Tractor and Hydraulic Loader in Pacific Northwest Lumbering operation

Webster Oil Hydraulic Pump in a Massey-Harris Tractor

• Dependable oil hydraulic power for tractors built by Massey-Harris—century-old manufacturer of quality farm equipment—is supplied in many different valve and cylinder variations by WEBSTER Gear-type Hydraulic Pumps.

Massey-Harris chose WEBSTER pumps for these reasons: Dependability and efficient operation in the field, easy mounting, and low cost power for mounted and pull-behind implements.

WEBSTER Hydraulic Pumps are available in a complete line from 10 gph. to 10 gpm., operating at pressures up to 1200 psi. at speeds of 3600 rpm or less—90 pumps of various designs and capacities to meet the widest range of applications. Internal relief valves are optional on all pumps.

We invite inquiry concerning your need for pumps for lubricating, oil circulating, transfer, filtering or oil hydraulic power applications. Mail coupon for full information.

Webster Electric Co., Racine, Wisconsin • Established 1909

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Dept. PE-4, Racine, Wisconsin.
Send me information on Webster Hydraulic Pumps as checked:
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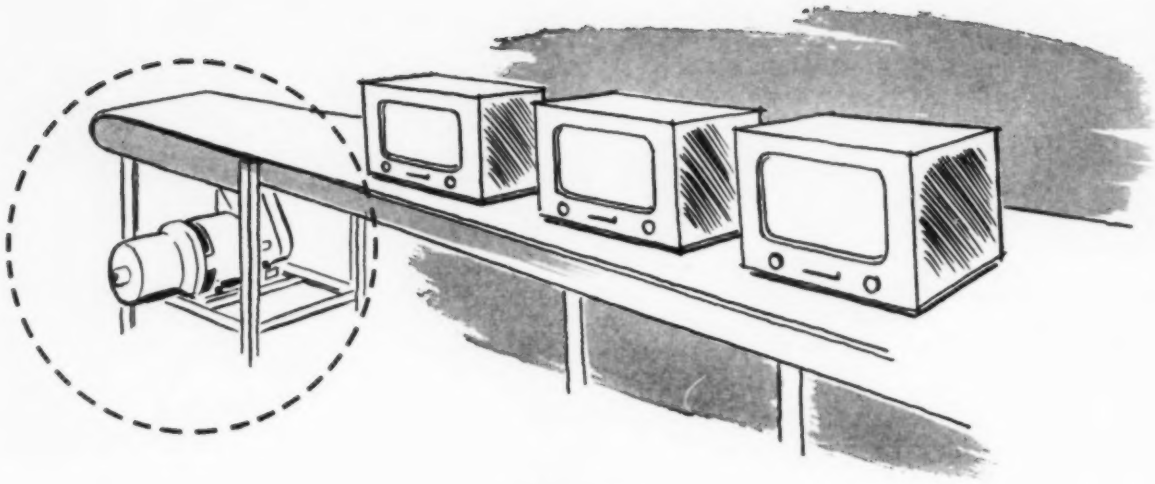
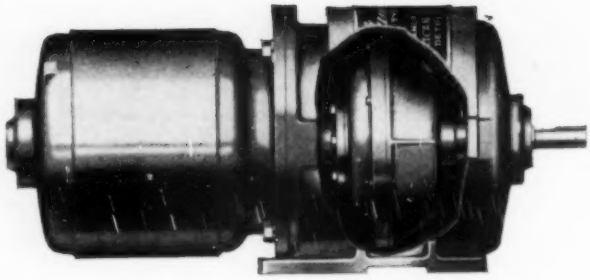
Pressure (Approx.)_____P.S.I.
Name and Title_____
Firm Name_____
Street Address_____
City_____Zone_____State_____

OIL HYDRAULICS DIVISION
WEBSTER ELECTRIC
RACINE WISCONSIN
"Where Quality is a Responsibility and Fair Dealing an Obligation"



How
GÝROL FLUID DRIVE
helps prevent conveyor breakdowns

On conveyors, an American Blower Type TM Gýrol Fluid Drive unit acts as an automatic shear pin. It can be stalled without damaging machinery and can be immediately started the moment the obstruction is removed. Fluid Drive provides smooth acceleration. This is important on long belt conveyors where the strength of the belt is usually only 35% above the normai motor ratings. With Fluid Drive, the starting period can be extended and the amount of power applied to the belt correspondingly reduced.



Cutaway view of Type TM Gýrol Fluid Drive unit

Facts about AMERICAN BLOWER Type TM Gýrol Fluid Drives

Power is transmitted solely by a vortex of oil. There's no mechanical connection between the motor and driven machinery.

They are completely assembled packaged drive units ready for operation on direct or belt-connected loads.

Type TM Gýrol Fluid Drives have standard NEMA mounting bolt hole dimensions and offer you the benefits of smoother acceleration, shock absorption and overload protection.

Free trial units are available to original equipment manufacturers

AMERICAN BLOWER

American Blower Corporation, Detroit 32, Michigan

Division of AMERICAN RADIATOR & Standard Sanitary CORPORATION

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS

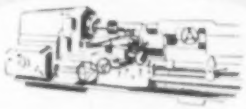
AEROQUIP SELF-SEALING COUPLINGS

AND FLEXIBLE HOSE LINES

BUSES AND TRUCKS

RAILROADS

OIL FIELD DRILLING RIGS

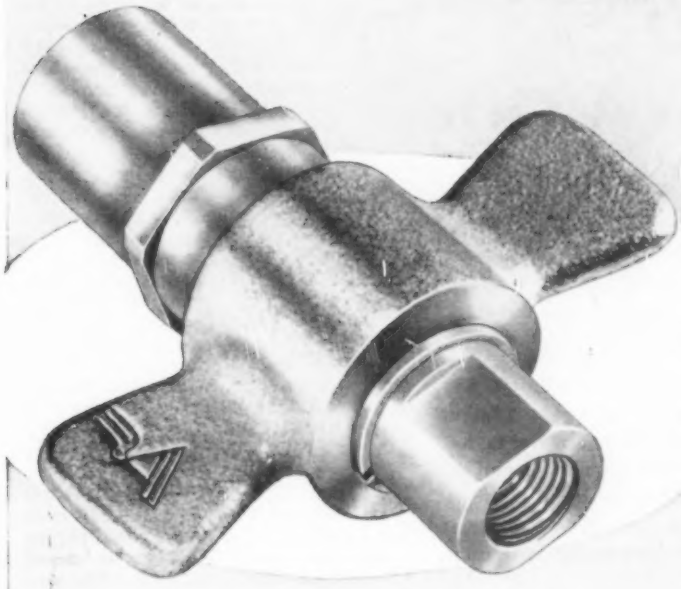


MACHINE TOOLS

MATERIALS HANDLING TRUCKS

Speed Maintenance

WHEREVER FLUID-CARRYING LINES MUST BE DISCONNECTED AND RECONNECTED



Speed maintenance, *speed* repair operations and *speed* interchanging of accessories joined by fluid-carrying lines with Aeroquip Self-Sealing Couplings. Lines may be separated in a few seconds without loss of fluid. No air enters the system upon reconnection. There is no need to drain or prime the fluid system. One Self-Sealing Coupling takes the place of two shut-off valves.

Aeroquip

REG. TRADE MARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

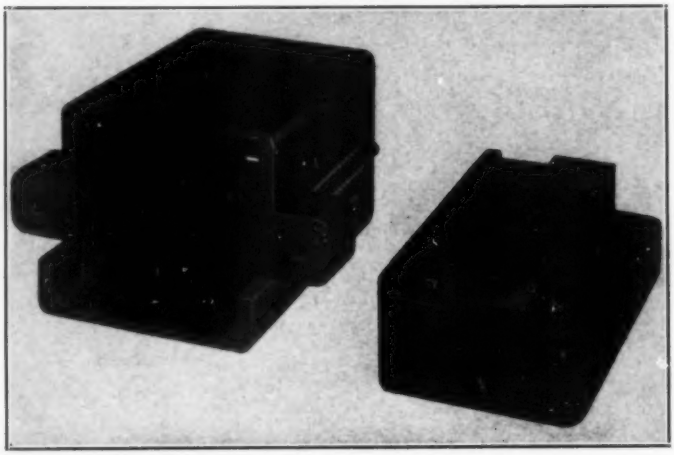
SALES OFFICES: BURBANK, CALIF. • DAYTON, OHIO • HAGERSTOWN, MD. • HIGH POINT, N. C. • MIAMI SPRINGS, FLA. MINNEAPOLIS, MINN. • PORTLAND, ORE. • WICHITA, KAN. • TORONTO, CANADA

AEROQUIP PRODUCTS ARE FULLY PROTECTED BY PATENTS IN U.S.A. AND ABROAD

Another Proof of

KUHN & JACOB

Molding Skill



The housing shown above for this

HEINEMANN

Silic-O-Netic Relay

is ample evidence of the accurate plastic molding done by this 34-year-old company. We have met the exacting requirements of the Heinemann Electric Company for more than 20 years.

Not only do we have a design and engineering staff thoroughly familiar with plastic materials and methods, but we maintain a complete mold making shop for production of the dies themselves. Thus we are able to exercise absolute control from design to finished piece.

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Have you

TEMPERATURE PROBLEMS IN BEARING APPLICATIONS?

If you do, you can find real help on this subject—as on so many others—in your *Annual HANDBOOK of Product Design for 1953.* An important, carefully detailed report in the *HANDBOOK* explains an empirical formula which enables the designer to specify speed, load, and lubrication requirements so that the bearing operating temperature will fall within safe limits.

Every new edition of your *Annual HANDBOOK* brings you a wealth of *permanently useful* data representing the significant developments of the year in the field of product-design engineering. This data, painstakingly selected from leading technical publications here and abroad, is specially edited for the *HANDBOOK*—sometimes condensed, sometimes expanded, always fully illustrated by photos, graphs, and charts. The *HANDBOOK* is completely indexed, and sectionalized into ten major classifications for easy reference to subject areas of particular interest to you. The report on operating temperature of bearings mentioned above, for example, is just one of many reports in the sixth section, *Design Analysis and Mechanical Parts,* of the '53 *HANDBOOK.*

In Mid-November, you will receive *The Annual HANDBOOK of Product Design for 1954,* even bigger and more informative than your widely acclaimed *HANDBOOK for 1953.* The new edition will again come to you as part of your regular subscription to *Product Engineering.*

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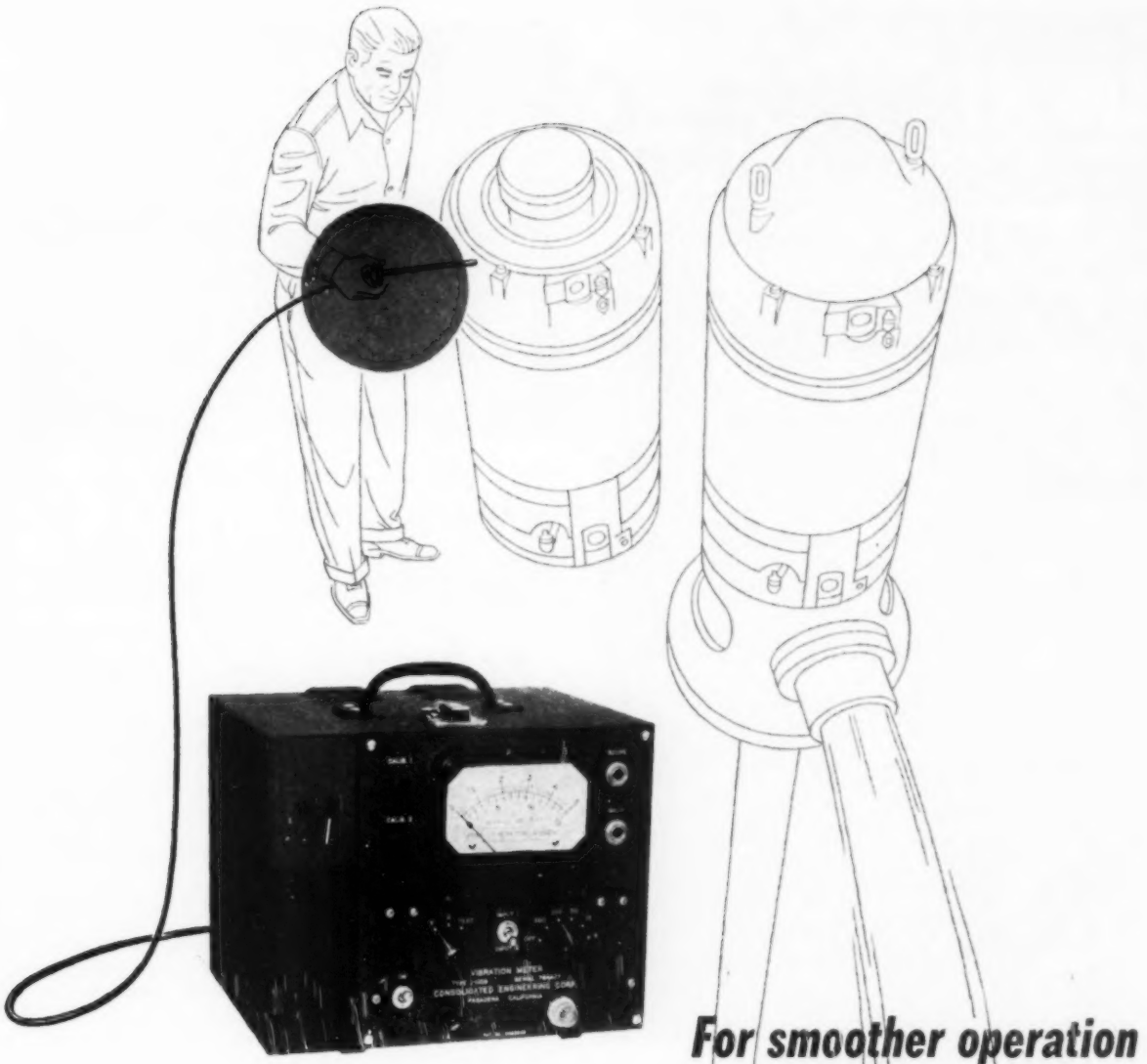

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EVERY MOTOR at U. S. Electrical Motors, Inc., is checked for dynamic balance before being placed in service. Vibration elimination, important in all motors, is vital to the satisfactory performance of vertically mounted motors that drive deep-well pumps. Their high centers of gravity magnify and transmit any imbalance through long vertical shafts to submerged pumps. To prevent damage to motor, shaft and turbine impellers, every U. S. Verticlosed motor is pre-checked with Consolidated instrumentation. Vibration monitoring is a profitable practice, paying off in greater customer satisfaction. If vibration elimination would improve your process or your product, our long experience in the field of dynamic measurement can help you.

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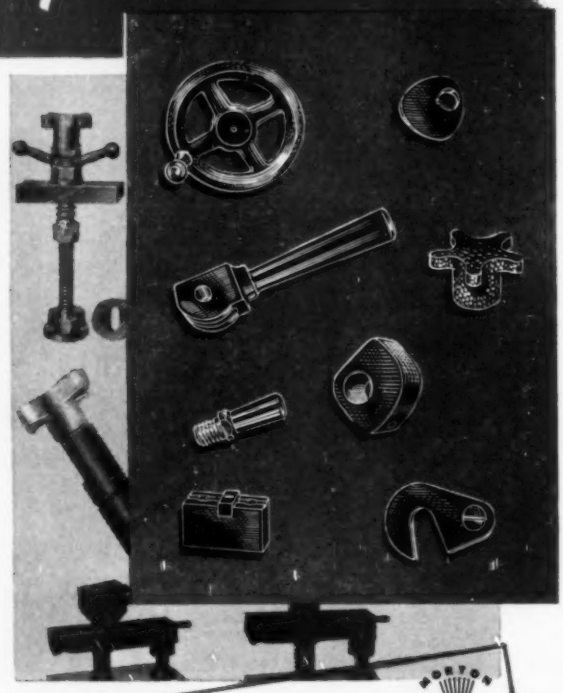
Fixture Clamps and Fixture Details



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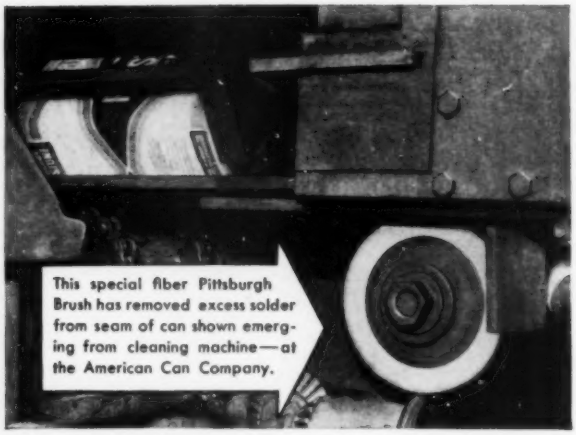


This special fiber Pittsburgh Brush has removed excess solder from seam of can shown emerging from cleaning machine—at the American Can Company.

"Wouldn't be without them!"

say the men who use . . .

Power-driven Pittsburgh Brushes for longer life, better work!

Last longer, much safer—Cloth brushes formerly used at the American Can Co., Jersey City, to wipe excess solder from can seams lasted less than an hour, occasionally caught fire. Switching to special fiber Pittsburgh Brushes, American Can now gets better than 15 hours life per brush and the fire hazard has been eliminated. Supervisory personnel reports: "We wouldn't be without them!"

Last longer, do better job—In producing wall and ceiling panels, at the Barclay Manufacturing Co., New York City, dust caused by routing "mortar lines" settles on the panels, must be completely removed before panels can be bake-finished. Brushes originally used had a short life span, wore unevenly, and did so poor a job that many baked panels had to be completely refinished to pass inspection. Since even a "fairly good" brush would not do, Barclay searched for the "perfect" brush—and chose Pittsburgh! Result: Better work, and costly refinishing eliminated.

Last longer, better constructed—The Windalume Corporation, Kenvil, N. J., manufacturers of aluminum windows, uses Pittsburgh wire brushes to remove burrs caused by milling. The wire bristles on the brushes used formerly broke off easily. Windalume replaced them with Pittsburgh Brushes because they are better constructed—and Pittsburgh Brushes last longer!

WRITE TODAY FOR FREE BOOKLET!

Write today for a free copy of our booklet that shows, through actual case histories, how Pittsburgh can help cut *your* brushing costs. Address: PITTSBURGH PLATE GLASS COMPANY, *Brush Div.*, Dept. W-6, 3221 Frederick Ave., Baltimore 29, Md.

PITTSBURGH

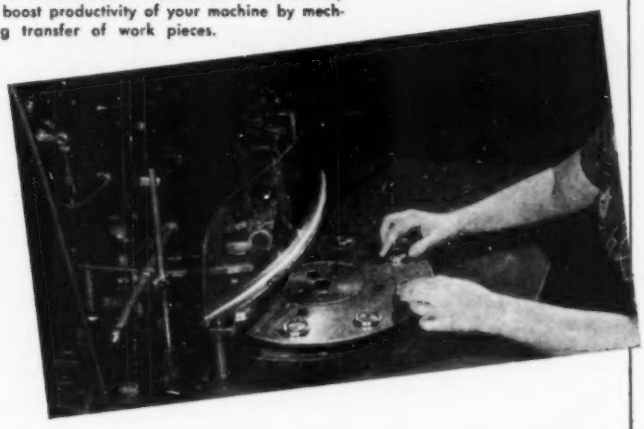
Power Driven

BRUSHES

BRUSHES • PAINTS • GLASS • CHEMICALS • PLASTICS • FIBER GLASS

PITTSBURGH PLATE GLASS COMPANY

Feed-O-Matic cuts time required for a secondary dieing operation from .210 of a minute per piece to .046 of a minute. Feed-O-Matic conceivably could boost productivity of your machine by mechanizing transfer of work pieces.

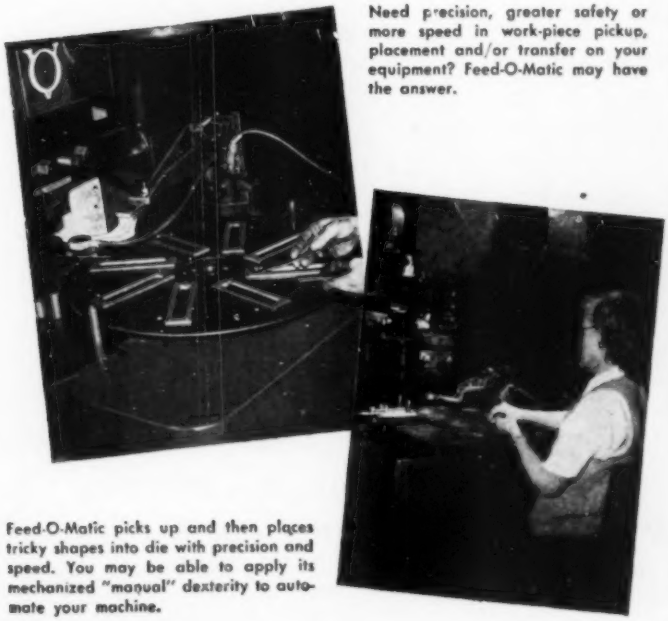


Ideas for 1960 .... or sooner

A mechanical hand designed to feed parts into punch presses can be "trained" to do the same job **wherever precision feeding is desired under difficult or dangerous conditions.**

The Feed-O-Matic "mechanical hand" has added safety, speed and certainty to punch press operations. It can do as much for other machines. Its applications are a challenge to design engineers. With the Feed-O-Matic your 1960 model designs can come into being right now.

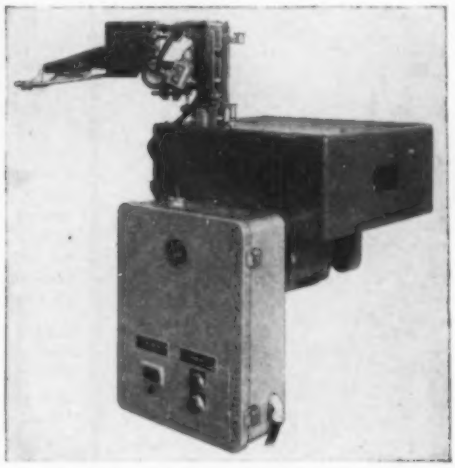
Need precision, greater safety or more speed in work-piece pickup, placement and/or transfer on your equipment? Feed-O-Matic may have the answer.



Feed-O-Matic picks up and then places tricky shapes into die with precision and speed. You may be able to apply its mechanized "manual" dexterity to automate your machine.

THE FIELD OF USEFULNESS IS WIDE OPEN RIGHT NOW

We have not worked out Feed-O-Matic design details for every possible application. But our engineers will be glad to work on them with you for *your* applications.



1. SAFETY

No part of any human body need even approach a danger zone. For eye hazardous conditions the Feed-O-Matic need not even be in sight.

2. SPEED

The Feed-O-Matic is synchronized with the machine it serves. It wastes no motions, never gets tired.

3. CERTAINTY

Precision pickup and placement of parts, and if desired, automatic shut-off of power if anything fails to function properly, are only two of the features that cause the Feed-O-Matic to add certainty to machine operations.

FEED-O-MATIC BROCHURE describes use of this device in secondary die operations. Will give you details on its basic principles. Please write Dept. P for your copy.

Only the best is good enough

THE V & O PRESS COMPANY

DIVISION OF EMHART MFG. CO.

HUDSON, NEW YORK

Builders of Precision Power Presses and Feeds Since 1889

Think of Perkins first and you can think of maintenance last!

WHEN the functional efficiency of your product is largely dependent upon the effectiveness of its integral power transmission system, the quality of the gears you need to transmit power is the major consideration.

Through its entire 35 years of operation, Perkins has specialized in the production of gears to customers' specifications—any size, any quantity, metallic or non-metallic. Consequently, among consumers of custom-made gears, PRECISION & PERKINS are accepted as synonyms. For trouble-free power transmission, specify Perkins custom-made gears. Have us quote on your requirements!

NOTE 1: A new product is the **Perkins Precision Spring Coiler.** This coiler (patent applied for) turns out precision springs – any type, shape, size, from wire sizes .005 to .125.

2: Another new product – the **Perkins "Bendit 15"** – a patented metal forming machine bends and shapes sheets, rods; strips tubing into innumerable complex as well as simple forms that would be difficult or impossible to make by other means. Eliminates need for expensive tools or specialized skills. Ht. 47", net wt. 200 lbs. Write today for descriptive catalogs, prices etc.

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This is an aircraft engine gear custom-made by PERKINS.

PERKINS ALSO MAKES:
Helical Gears
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Spur Gears with shaved or ground teeth
Ground Thread Worms

Do you want help in selecting the best switch for the job?

•

You will be in a better position to determine what switches are best suited for many different service requirements after you consult the data given under the title, "Your Next Switch Selection Problem," in *The Annual HANDBOOK of Product Design for 1953.*

That is just one of the subjects expertly examined in the great wealth of reports in the *HANDBOOK*—reports covering a year's most significant developments throughout the product-design engineering field. Be sure that you take advantage of the data in your *HANDBOOK* whenever you are faced with difficult problems in your work.

Another *HANDBOOK* will be ready in Mid-November. It will put into your hands an even more complete and helpful compilation of important product-engineering information than does the current enthusiastically acclaimed '53 *HANDBOOK.*

The next *HANDBOOK* again will be divided into ten major subject classifications, for easy reference to data of special interest to you. It will be completely indexed, and in addition will contain an index of the *HANDBOOK for 1953.* And, as before, the *HANDBOOK* will come to you as part of your regular subscription to *Product Engineering,* at no extra cost!

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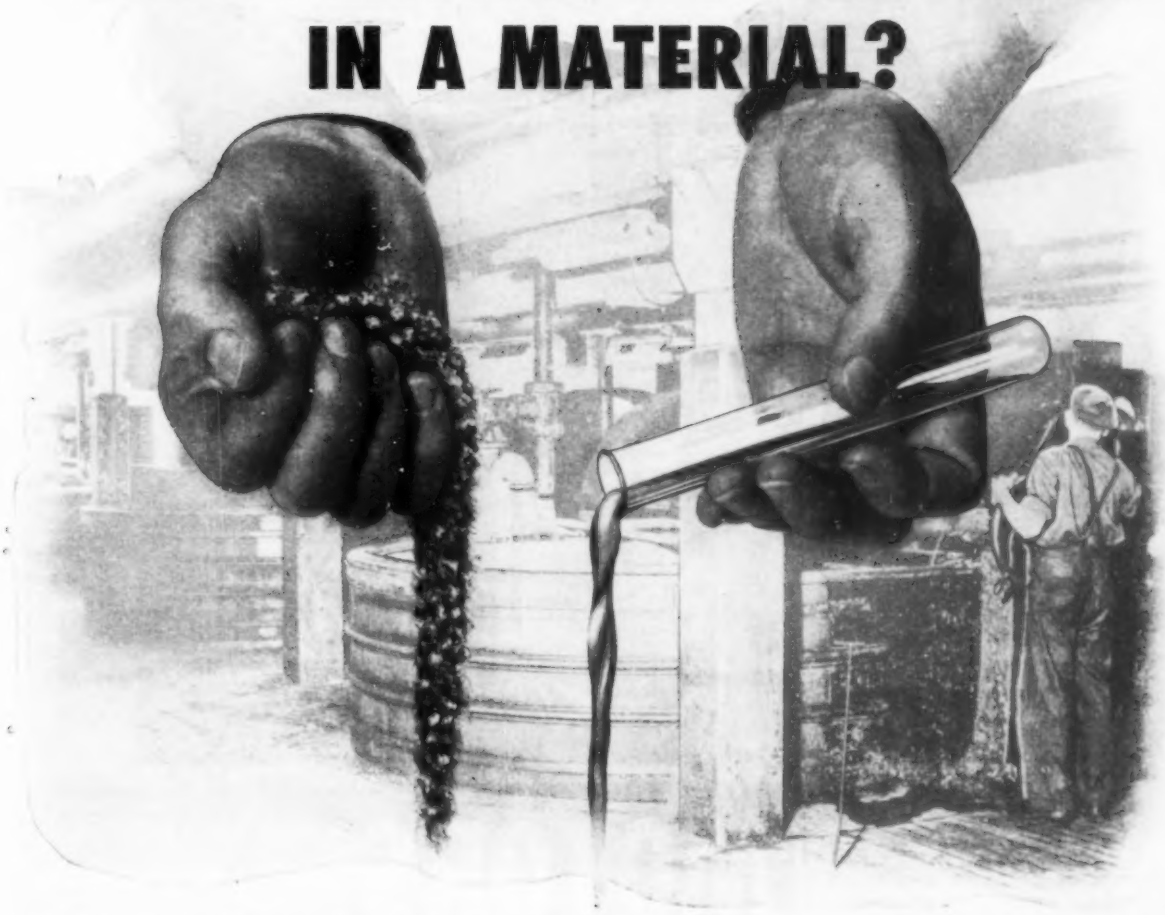
WHAT EXTRAS DO YOU NEED IN A MATERIAL?



ROGERS BLENDS CHEMICALS AND FIBRES TO PRODUCE MATERIALS

WITH SPECIFIC MECHANICAL CHARACTERISTICS

WITH SPECIFIC CHEMICAL CHARACTERISTICS

WITH SPECIFIC COMBINATIONS OF MECHANICAL AND CHEMICAL CHARACTERISTICS

● Working on a design improvement that requires a special material to complete? That's a natural for Rogers. You can — within a wide range of fibrous and impact phenolic materials — literally dictate the characteristics you need.

Our gasket materials, for example, can be made to meet varying requirements for compressibility, recovery and heat resistance. Our hard fibrous materials can be varied to cope with special problems in insulation, spacing, mounting, even packaging.

For more information, please write for our catalogs, Dept. E, Rogers Corporation, Manchester, Connecticut. Or request a visit from our nearby sales engineer.

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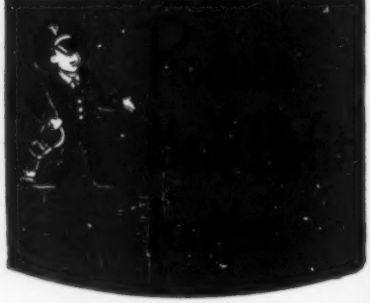
SCREWS • BOLTS • NUTS



MAINTAIN PEAK OUTPUT with Pheoll precision-made screws, bolts and nuts—they will speed your assembly work and improve product appearance.

INSURE PRODUCT PERFORMANCE with Pheoll quality screws, bolts and nuts—standardize on these dependable industrial fasteners.

HUGE MANUFACTURING FACILITIES assure rapid production of both standard and special fasteners.

SINGLE SOURCE OF SUPPLY for screws, bolts and nuts in different sizes, types and metals.

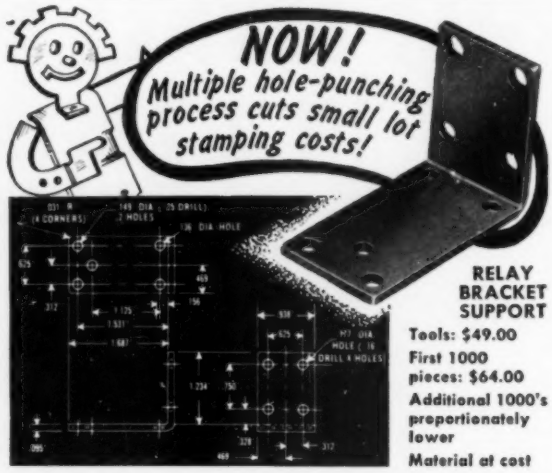
OVERNIGHT DELIVERY to principal cities from centrally-located Pheoll factory and warehouses.

FACTS ABOUT Pheoll YOU SHOULD KNOW

- One of the nation's leading producers of industrial fasteners.
- Pheoll products are widely used in part assembly when quality is of prime importance.
- Men who produce Pheoll industrial fasteners are highly trained and experienced craftsmen.
- All products are manufactured under rigid quality control standards.
- Constant product inspection from laboratory metal analysis, through production and final finish is your assurance of precision made, trouble-free screws, bolts and nuts.

Write for this free Bulletin

PHEOLL SCREWS BOLTS



RELAY BRACKET SUPPORT

Tools: $49.00
First 1000 pieces: $64.00
Additional 1000's proportionately lower
Material at cost

FREE...

Write for sample with cost summary and Bulletins 101 and 161 giving the complete Federal stamping story.

9 holes—2 different diameters—*punched simultaneously using Federal's new multiple hole-punching process!*

PRECISION die cut stampings in short runs involving hole-punching can now be made at even lower piece prices with Federal Tool's new multiple hole-punching process. Savings in press time and reduction in number of operations performed result in lower stamping costs. Before you buy . . . try Federal. Send your prints for lower cost quotations.

Federal TOOL AND MANUFACTURING CO.
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"QUALITY STAMPINGS IN SMALL QUANTITIES"

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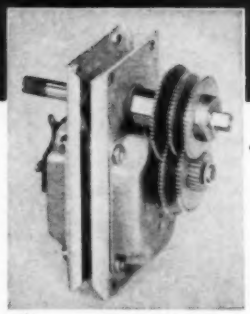
- Built for YOUR job
- Built for economy
- Built for dependability

Whatever your product, if you have an application that calls for a rugged, always reliable source of fractional h.p., you'll want to work with EEPCO engineers.

Out of the tremendous variety of power problems solved by EEPCO has come a reputation for compact, workable design that is unsurpassed in industry. Concentration has always been on providing a power source that easily meets the products requirements . . . that is efficient and economical under all condition of service.

Of course, we'll work to your specifications, or will be glad to furnish you with our complete engineering service for new designs to help improve your product's performance.

Check with EEPCO today.



EEPCO INGENUITY AT WORK

This is an EEPCO-designed reversible motor with gear train added to obtain desired reduction where low speed and high torque are required. Adapted for both continuous and intermittent operation, this Model AC-490-C motor weighs only 10 ounces and is precision-made for durability.

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609 W. LAKE STREET, CHICAGO 6, ILLINOIS

• P-M DC MOTORS & GENERATORS • CAPACITOR TYPE MOTORS • UNIVERSAL MOTORS
• DC MOTORS & GENERATORS • SHADED POLE MOTORS 2-4-6 Pole • P-M AC GENERATORS

Now... they're even PUMPING POTATO SALAD!

An example showing how the versatile MOYNO PUMP may solve your pumping problem

As you can imagine, any conventional pump would quickly make *mincemeat* out of potato salad! But not the versatile MOYNO Pump! In fact, this unique pump was the answer to a years-old materials handling problem in an Eastern food processing plant.

Why? Because of the Moyno "*progressing cavity*" *principle*—found in no other pump. Instead of valves and pistons that stick, or vanes that cause churning and turbulence, the Moyno has a simple rotor, operating within a stator. The small illustration shows how progressing cavities are formed as the rotor turns. These cavities move along smoothly, without closing up or squeezing the material. That's why Moynos carry liquids, pastes, solids in suspension, abrasive-laden slurries—*almost anything that will go through pipe*—with positive, non-pulsating pressure!

Potato salad is only one of the many successful, dramatic applications for Moyno Pumps. You may be able to save money or solve a problem by finding out more about the world's simplest, most versatile pump!

If you have a pumping application—in your plant or in your product—write today for free copy of Bulletin 30-P1. It will give you complete facts!

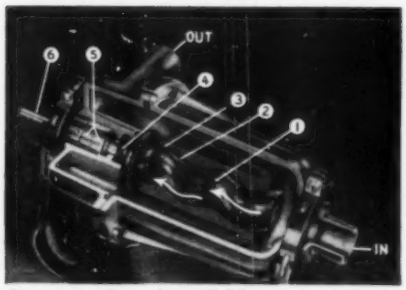
Features of the MOYNO that may solve YOUR pumping problem

Positive Displacement—Moynos are available to pull up to a 29" vacuum while discharging under pressure. Big Moynos deliver up to 250 g.p.m. at pressures to 600 p.s.i.

Gentle—no churning; won't break up semi-solids . . . won't aerate liquids.

Reversible—pumps with equal efficiency in either direction.

Trouble-Free—self priming; won't cavitate or vapor-lock. Just one moving part—no valves to stick, no pistons to gum up. Built for tough service. Easy to maintain.



Cutaway view of small Moyno suitable for washers, drink dispensers, gasoline pumps and oil burners, circulating liquids, etc. As rotor (1) turns, cavities (2) move toward end of stator (3). Automatic shaft seal (4), precision ball bearings (5), drive shaft (6). May be designed to meet your problems.

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Fractional & Integral h.p. Motors & Generators

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"I could see the corpsman kneeling over me. The blood plasma was running down through a tube into my arm and he said everything was going to be O.K. I was walking across an enemy mine field in Seoul when one exploded and a piece of shrapnel caught me in the leg.

" 'Got enough of that stuff?' I asked him, pointing to the blood. 'I guess we never have enough,' he said, 'but you can thank *somebody* for this pint.'

"How do you thank 'somebody' for blood? For saving your life? When I got back home, I discovered the answer at my local blood donor center. There's only *one* way to say thanks—by giving some of your own blood."

"How do you thank 'somebody' for Blood?"

Yes, all kinds of people give blood—for all kinds of reasons. But whatever *your* reason for giving blood, this you can be sure of: Whether your blood goes to a combat area, a local hospital, or for Civil Defense needs—this priceless, painless gift will some day save an American life!

Business Executives!
√Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
- ☐ Do you have a Blood Donor Honor Roll in your company?
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of co-operation?
- ☐ Was this information given through Plant Bulletin or House Magazine?
- ☐ Has your company given any recognition to donors?
- ☐ Have you conducted a Donor Pledge Campaign in your company?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

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What production problems are solved by each of these five processes used in making precision gears? What are the advantages of each process—what are the limitations?

An eleven-page report, fully illustrated by charts and photographs, examines these five gear-forming processes in detail in your *Annual HANDBOOK of Product Design for 1953.*

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In November, you will receive the *HANDBOOK for 1954.* The new *HANDBOOK* will be even bigger and more informative than the tremendously popular *HANDBOOK for 1953.* And it's part of your regular subscription to *Product Engineering!*

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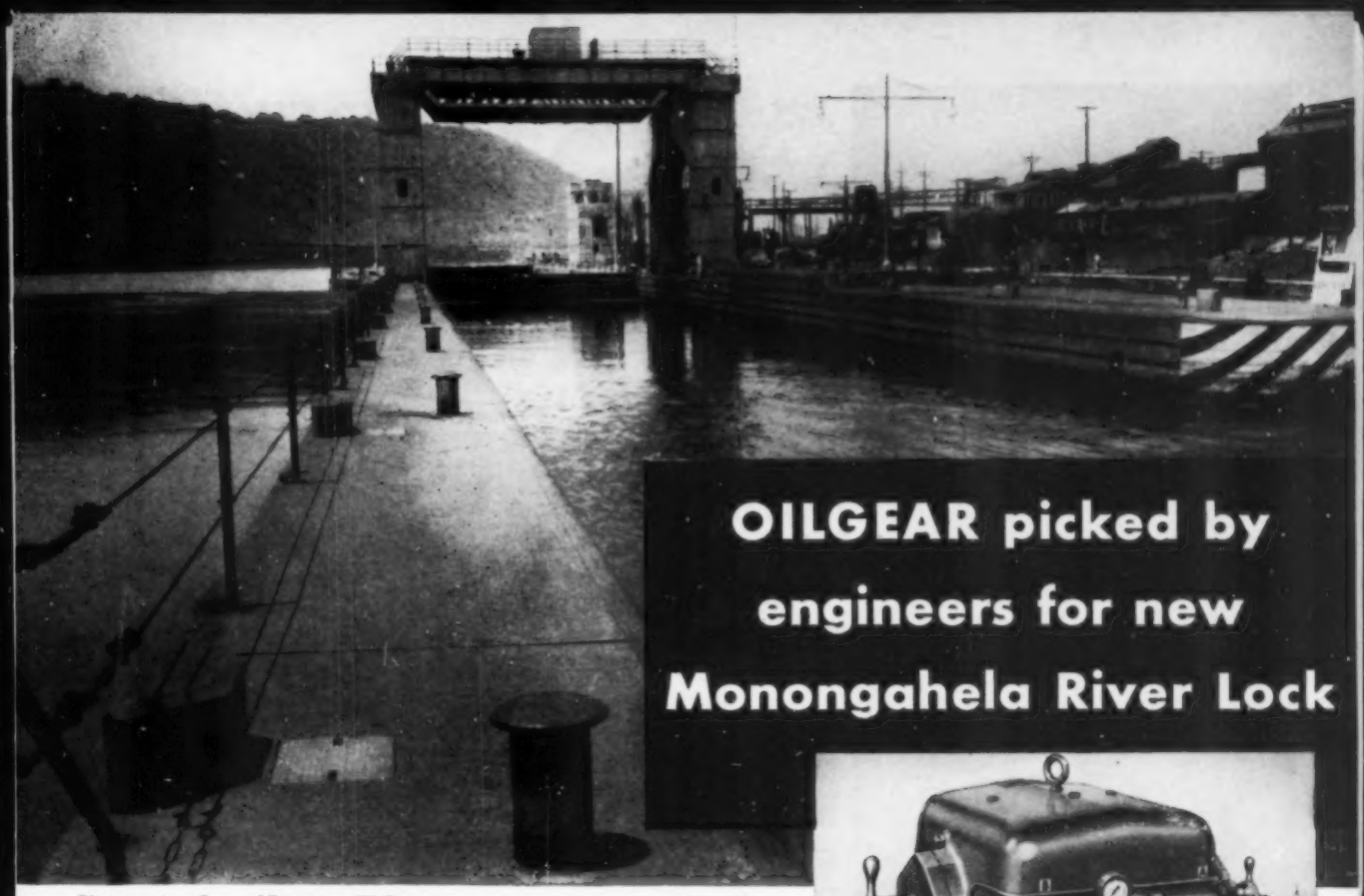

OILGEAR picked by engineers for new Monongahela River Lock

Photo courtesy Corps of Engineers, US Army

This versatile fluid power also used in McNary Dam and Bayou Boeuf Locks

Oilgear Two-way Variable Delivery Pump with Electro-hydraulic Three-position Remote Control.

The problem of selecting the power to operate the lock gates, butterfly valves and capstans in the new Monongahela River Lock was to provide the speed of operation, the capacity and the dependability that would keep the rapidly growing volume of shipping on the move. The river at this point now handles millions of tons more annually than Panama.

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But we are inclined to stress the *versatility* of Oilgear Fluid Power . . . its applicability to a wide range of needs ranging from the impressive capacity required for lock operation . . . to the delicate and assured precision, controllability and accuracy required in printing on flimsy cellophane . . . and to the middle ground of industry where production must always be increased and always kept on the move.

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permit full-scale regulation of flow for many different circuit needs, at pressures to 3000 psi. Infinitely adjustable within each range of control . . . cartridge-type single-spool design adjusts easily to various pump deliveries without changing spools. 2-port and 3-port types, with or without built-in check. ¼", ⅜" and ¾" sizes; 0 to 28 gpm capacities.

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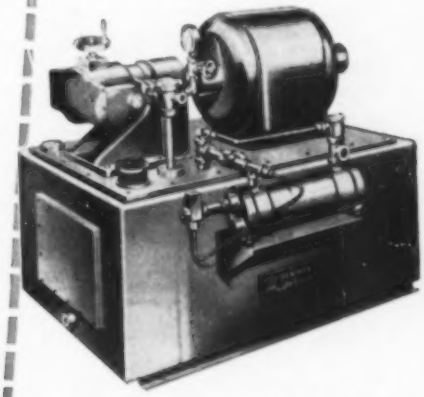

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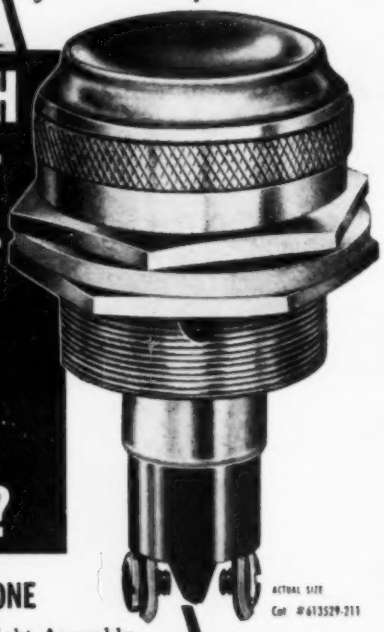

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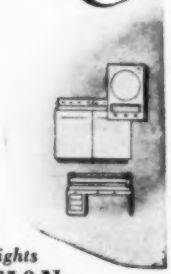

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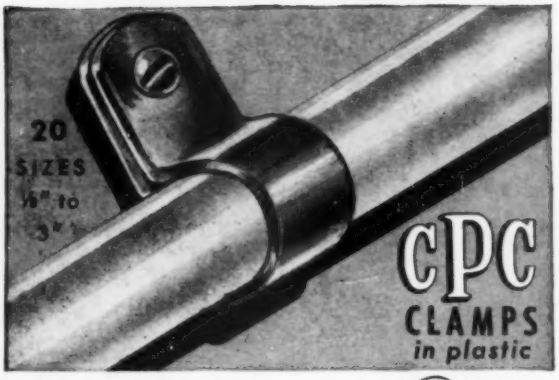

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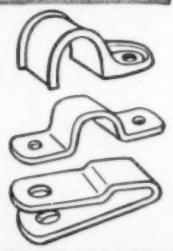

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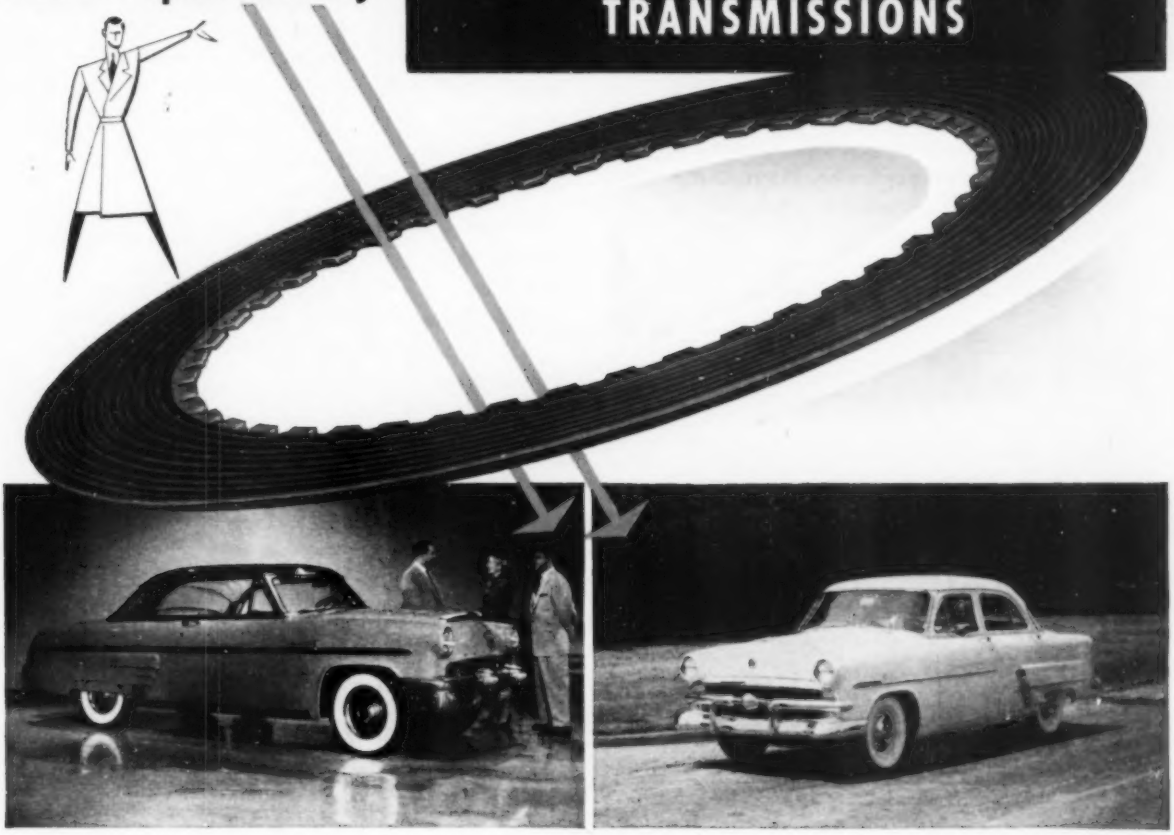

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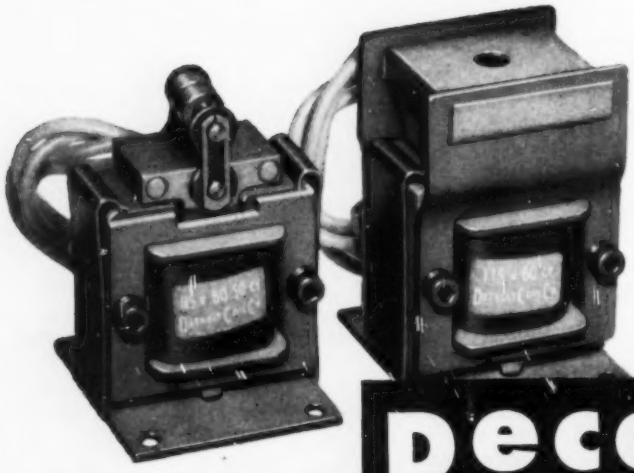

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Is there any data available on elastic elongation of chains?

Actually, until very recently there has been little or no data available to designers regarding elastic elongation of various types of chains. A report in your *Annual HANDBOOK of Product Design for 1953*, however, for the first time outlines and shows in table and graph form the results of extensive tests to determine accurately the average elastic elongation of single strand ASA roller chain, double pitch conveyor chain, and cable chain.

The *HANDBOOK*, published for the first time last November, has earned the acclaim of design engineers everywhere for its abundance of up-to-the-minute and lastingly useful product engineering data. All the vital information in the *HANDBOOK* is separated into ten major classifications and fully indexed so that you can easily find exactly the data you particularly want. For example, the report mentioned above, titled "Elastic Elongation of Chains," is found in the section on *Power Transmission*.

Another edition will be along to join your '53 *HANDBOOK* in November. *The Annual HANDBOOK of Product Design for 1954* will present an even broader, more informative selection of data important to you in your work. Again, you'll receive the *HANDBOOK* with your regular subscription to *Product Engineering*, at no extra cost.

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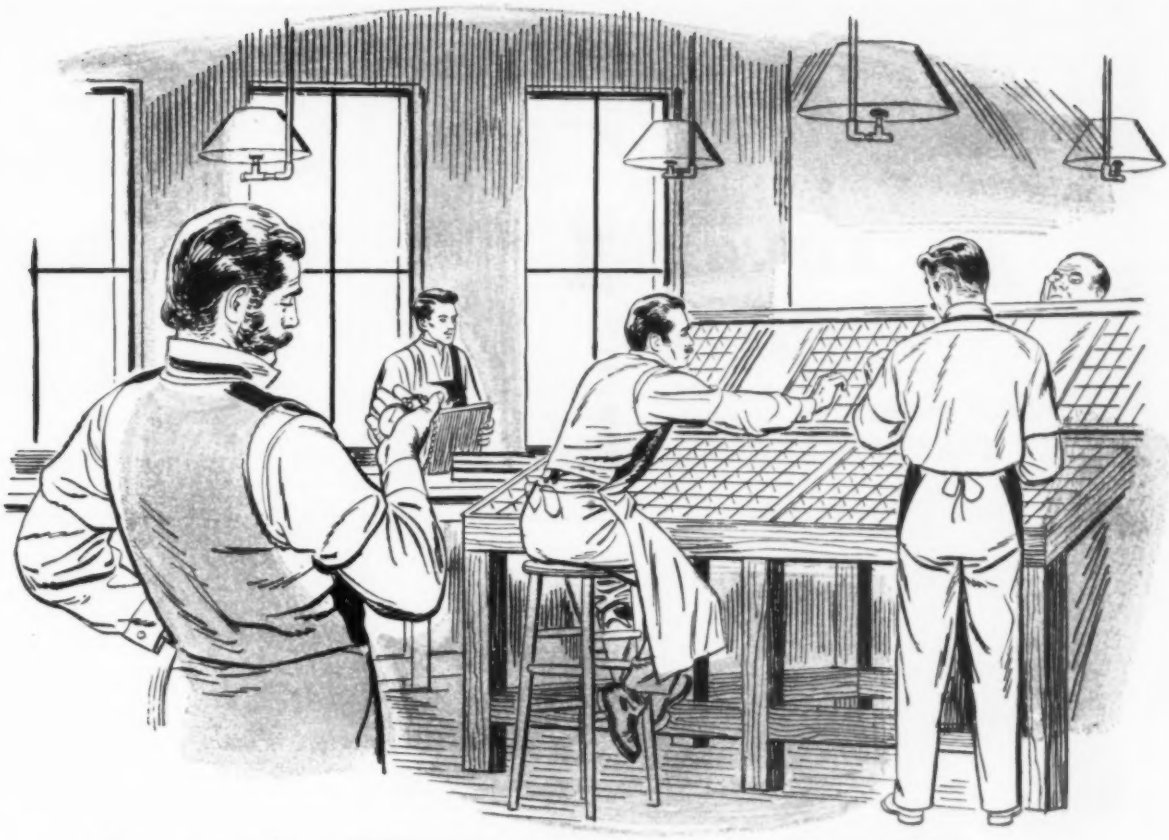

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Consult with us, without obligation, about motors for your regular or new products. Standard Motors are made in horsepower ratings 1/20 to 5 H.P., and Hermetic Motor parts 1/8 to 15 H.P. *Write...*

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- ☐ M402-D Fan-Duty
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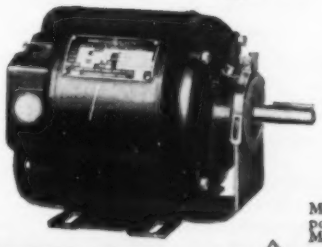
- ☐ M402-F Jet Pump
- ☐ M402 G Blower



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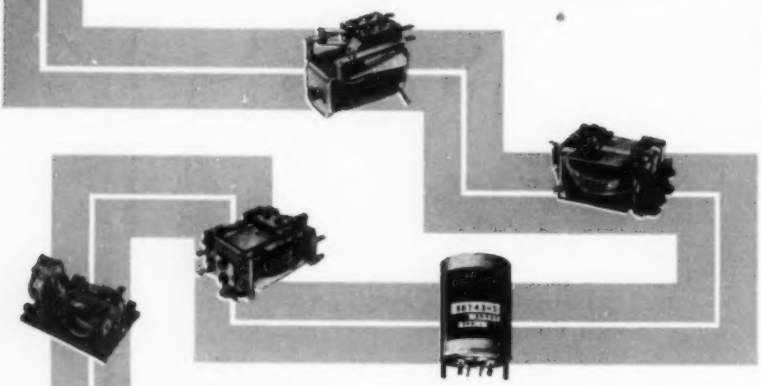

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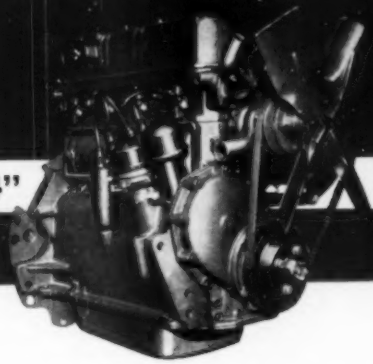
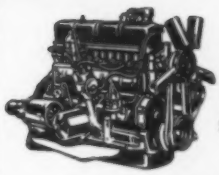


FORD "134" 4-CYL., O.H.V.

Ford's Overhead Valve Industrial Engines have been thoroughly tested and highly accepted for industrial applications in the field, and now a 4-cylinder power plant of the same type is being offered. This Ford "134" cu. inch engine incorporates notable advancements for still greater performance and operating economy. **Bore:** 3.4375 in. **Stroke:** 3.6 in. **Rating (dyn.):** 45 b.h.p. @ 2400 rpm.



FORD "215" 6 cyl.
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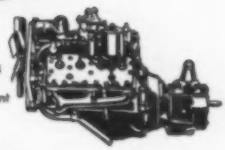

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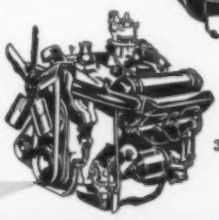
Industrial Engine
239 cu. in. displacement

FORD "254" 6 cyl.
Industrial Engine
254 cu. in. displacement

FORD "279" V-8
Industrial Engine
279 cu. in. displacement



FORD "317" V-8
Industrial Engine
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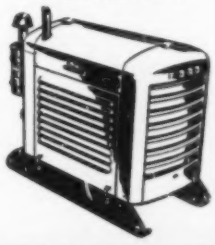
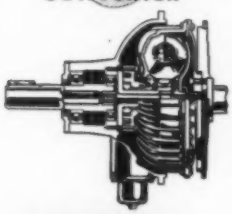


FORD MULTA-TORQUE CONVERTER



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Product Engineering

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Dayton Cog-Belt* solves TOUGH DRIVE PROBLEM

The Problem:

The successful operation of this coin counting machine required small pulleys, and a very long V-Belt which had to "take" a murderous back-breaking reverse bend.

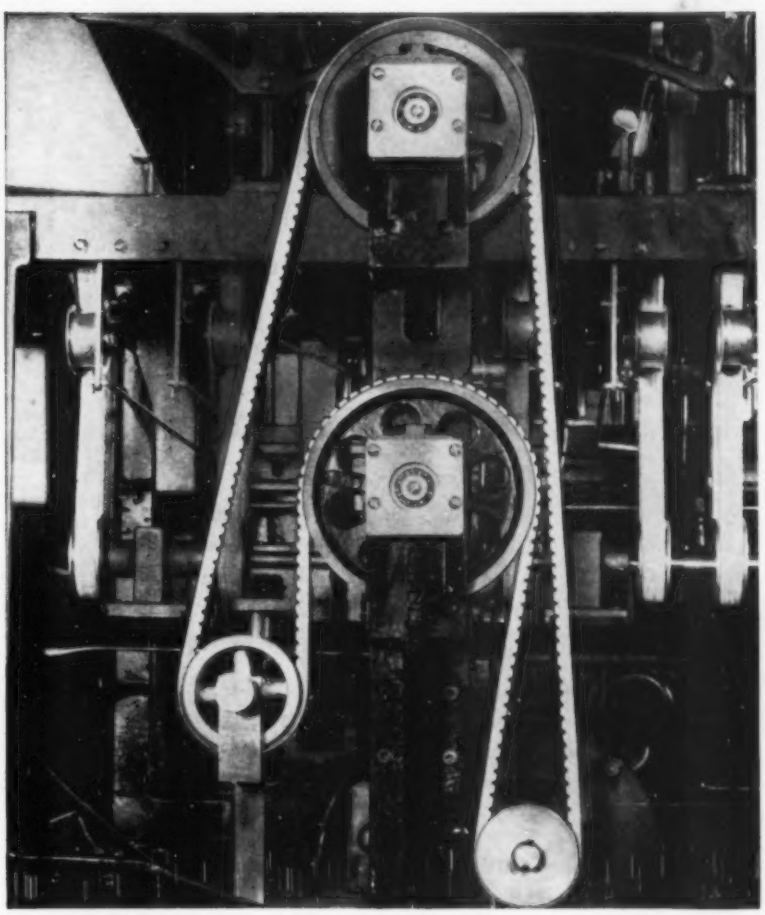
Attempted Solutions:

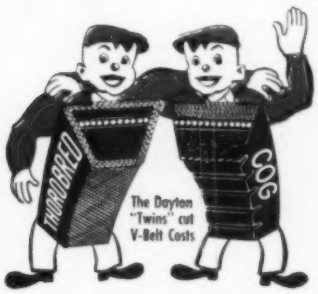
Conventional V-Belts failed after only two months. Even double-angle V-Belts failed in six months.

Real Solution:

Dayton Cog-Belts were installed. They have been in service more than a year with no sign of failure yet.

*T.M.





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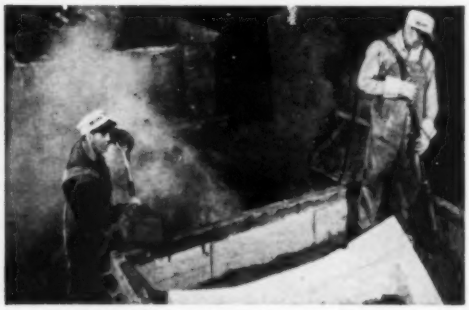
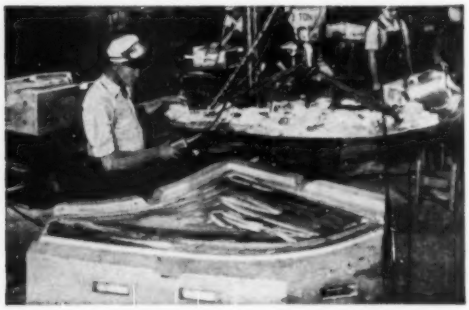
Pattern Making includes wood models or plaster models made from a loft template set-up, starting from an idea, a model, or a blueprint.

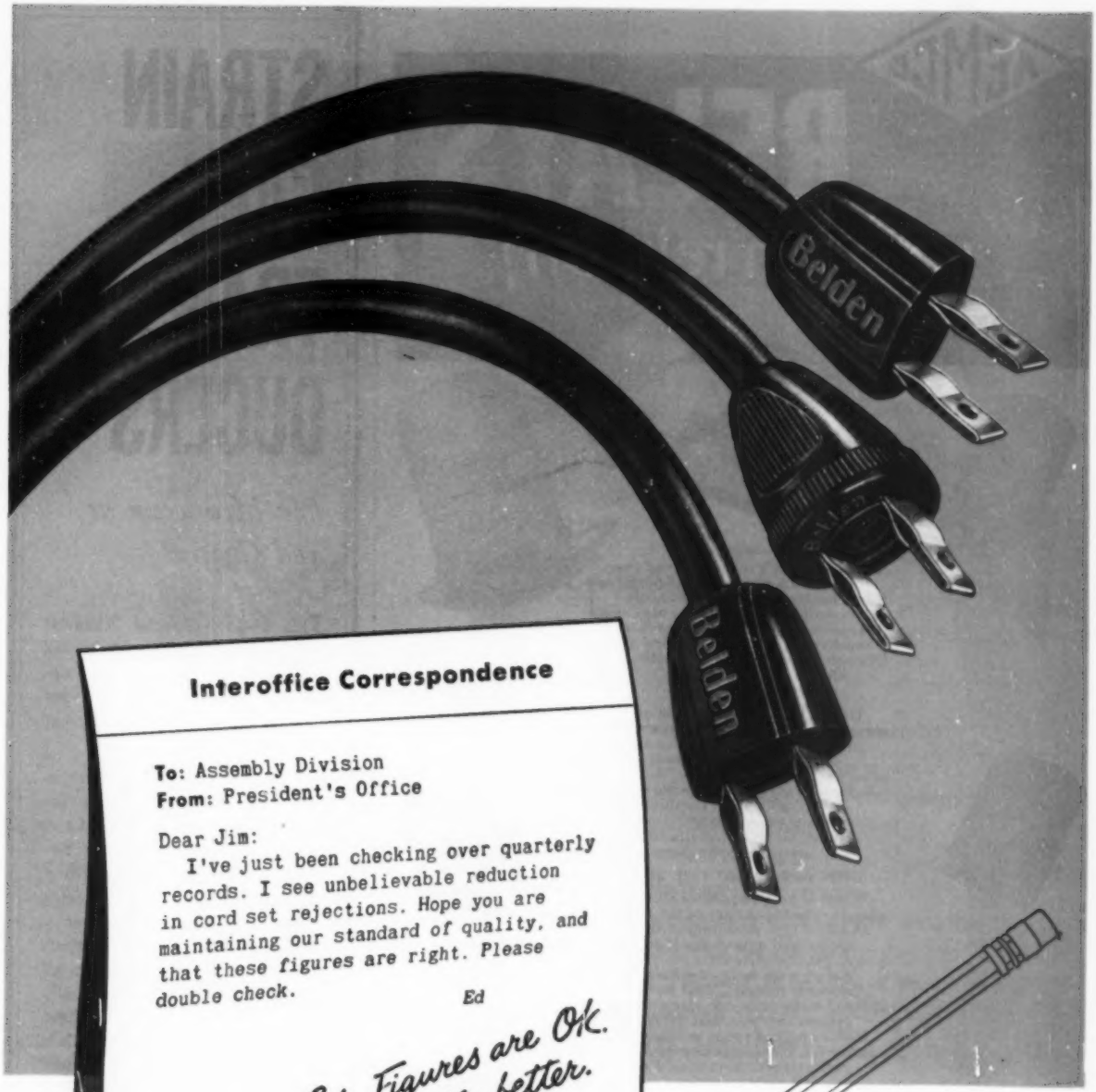


Sand Casting includes the molding and pouring of dies of any size or shape using special techniques in coring to reduce die weight.



Die Finishing includes grinding, drilling, planing, etc., to accurately finish dies to low tolerances by means of plaster check jigs, and templates.

Press Stamping and Finishing includes determination of cutting metal clearance, draw radii, drawface relief, etc. Also includes trimming, welding, re-working and spray-painting.



Interoffice Correspondence

To: Assembly Division
From: President's Office

Dear Jim:
I've just been checking over quarterly records. I see unbelievable reduction in cord set rejections. Hope you are maintaining our standard of quality, and that these figures are right. Please double check.

Ed

Dear Ed- Figures are OK. Quality is actually better. Answer simple - we changed to Belden Cords.

Jim

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3. Fewer Rejects
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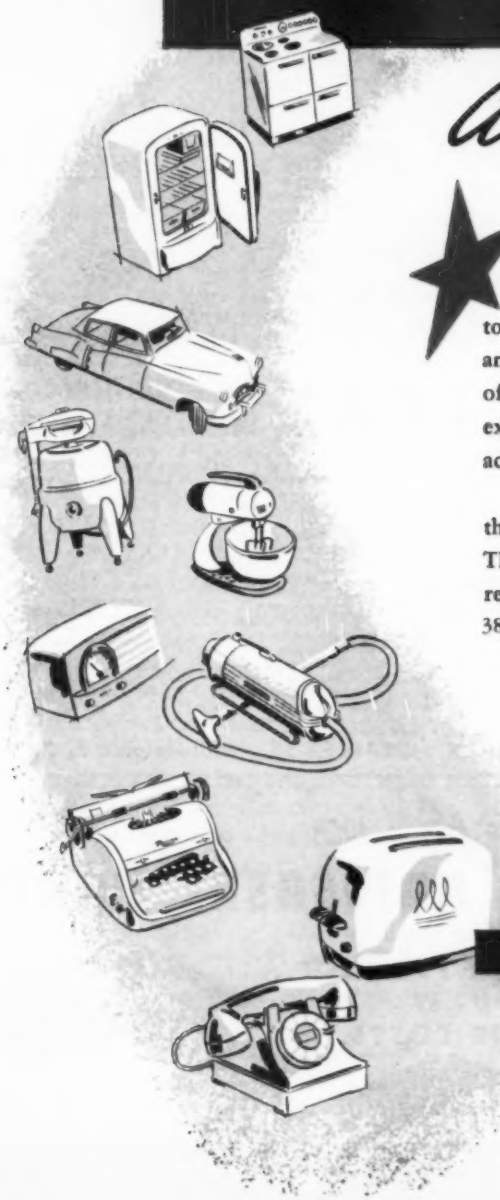

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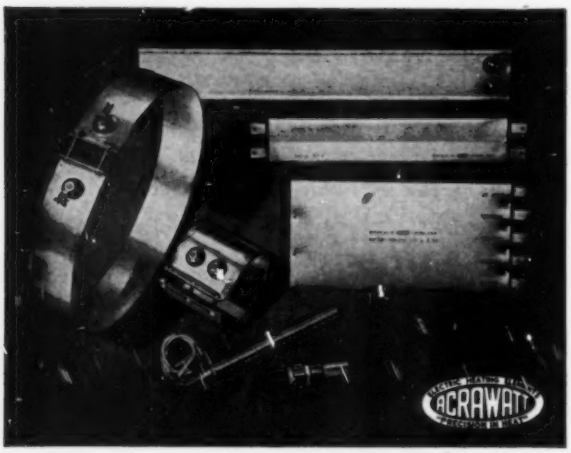

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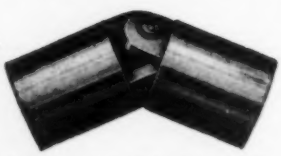

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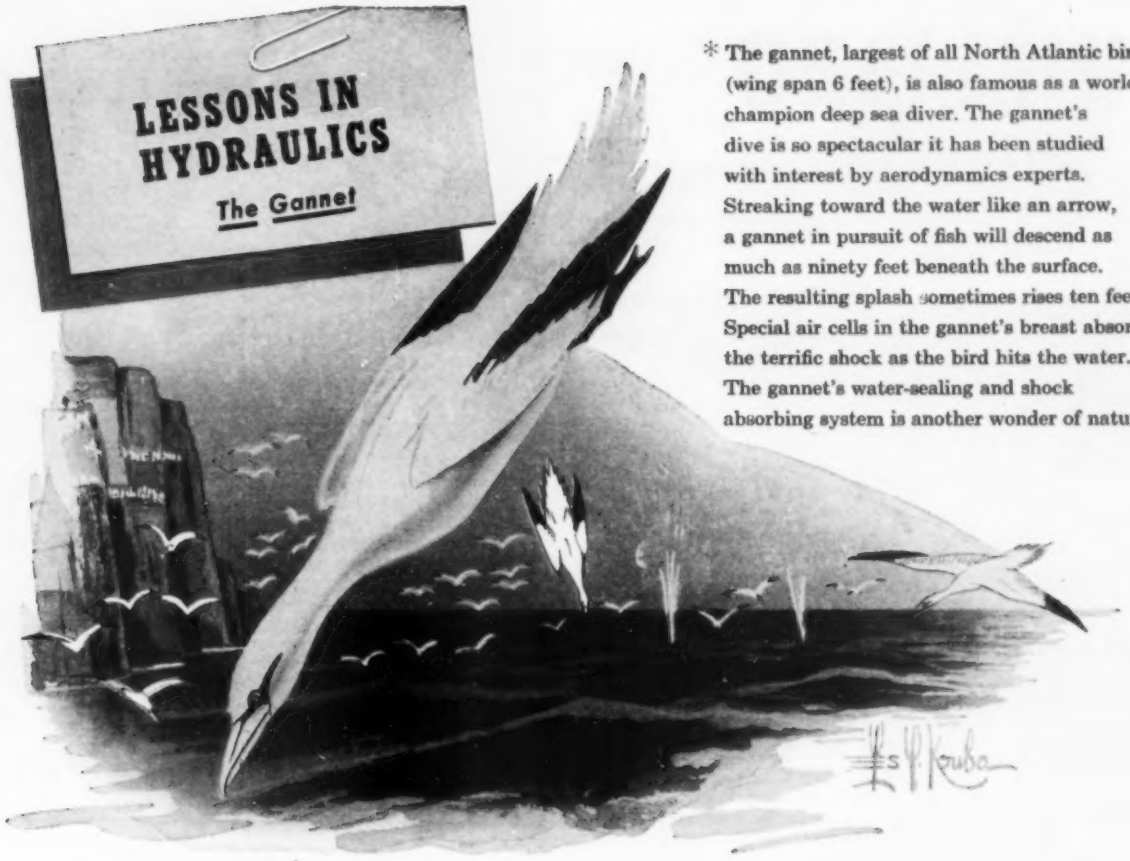

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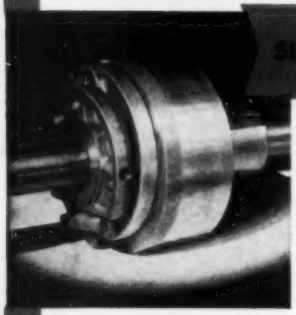

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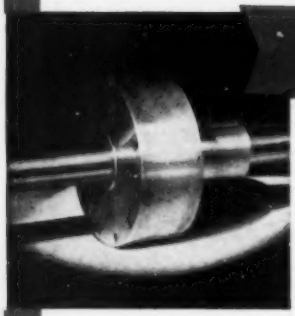

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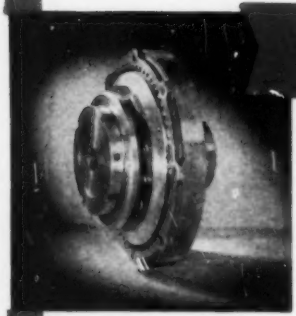

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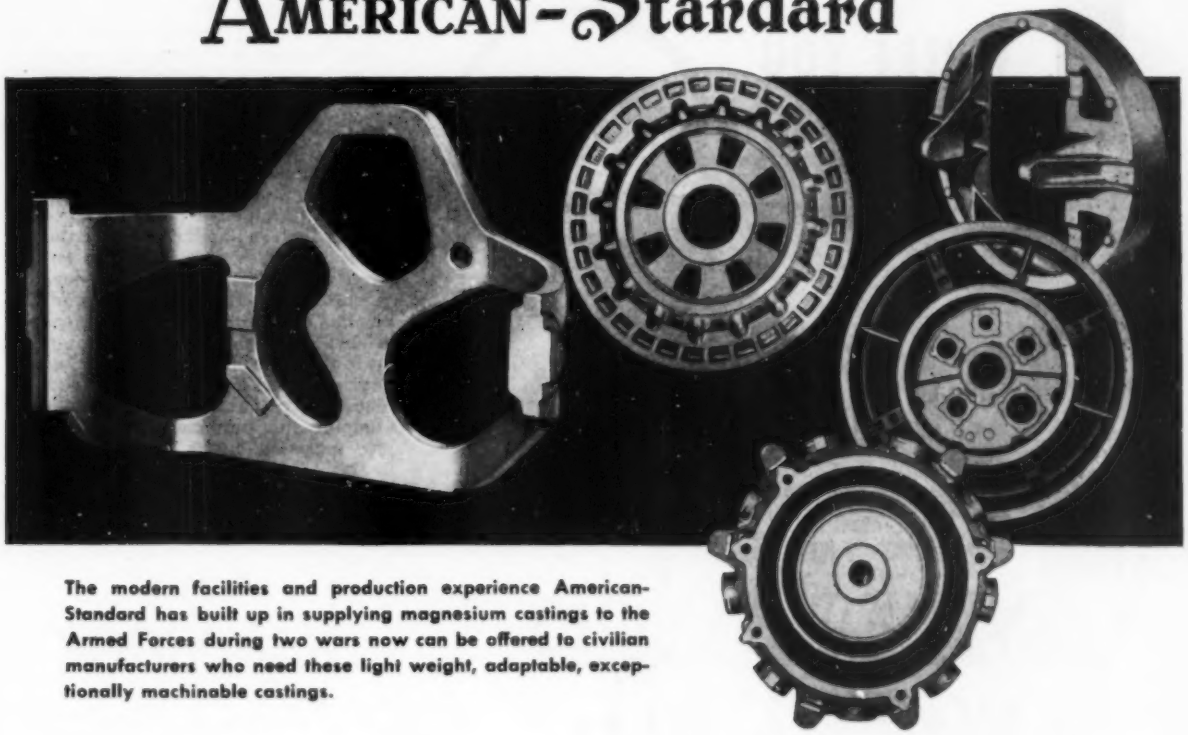

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The Annual HANDBOOK of Product Design for 1953, which you received last November, was the *first edition* of this continuing, yearly service to you. Your thousands of inquiries and enthusiastic comments have represented to us the best possible evidence of your enthusiasm for this new service.

Clearly, the *HANDBOOK* brings design-engineers everywhere information they want and need. Into each issue of the *HANDBOOK* go hundreds of pages of product engineering data, carefully selected, edited, and illustrated to give you significant engineering developments as reported during the year both in the U. S. and abroad. Our special *HANDBOOK* staff searches through an array of technical periodicals which could never be adequately read by most busy men, to acquire the most helpful and permanently useful data for inclusion in the *HANDBOOK.*

You'll receive your *Annual HANDBOOK of Product Design for 1954* in November

The *1954 HANDBOOK* will be *even bigger* and more informative than the first edition. Both editorial and advertising pages will be completely indexed, and an index of the *1953 HANDBOOK* will be included. All data and advertising will be divided into ten major classifications, enabling you to locate exactly the subject matter you want quickly.

Your *HANDBOOK for 1954* will be sent to you in Mid-November as part of your regular subscription to *Product Engineering.*

Product Engineering

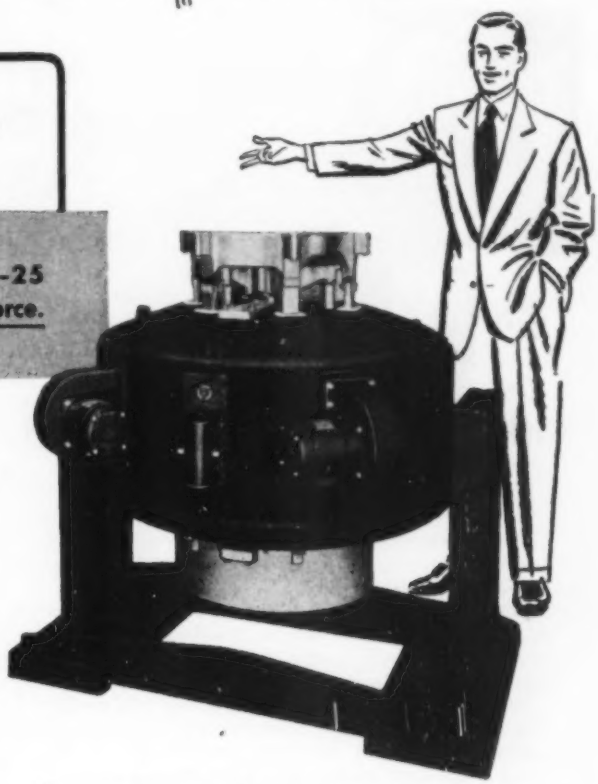
330 West 42nd St.

New York 36, N. Y.

Vibration Engineering that solves your problems

PROBLEM: To perform vibration tests to MIL-E-5272 and other specifications.

SOLUTION: The MB Model C-25 Vibration Exciter rated at 2500 lbs. force.



Shake testing gives a quick method of developing a product to withstand vibration. Such testing is vital for military equipment—and a good idea for any product. To meet this need, MB has applied its specialized vibration engineering to develop a range of shakers in various ratings for testing everything from electron tubes to airframes.

The big C-25 model illustrated develops large "brute forces" to satisfy specification MIL-E-5272. It has heavy duty capacity for a wide range of work, including fatigue testing. It features accurate, continuous control of force and frequency. Its control panel is available with an automatic cycling system for specific cycling tests called for in the MIL-E-5272 specification.

One of the largest and most dependable electromagnetic shakers available, the C-25 model is a good example of the quality of vibration engineering that has made MB "headquarters" for products to isolate, control, reproduce, detect, or measure vibration. More information on MB Vibration Exciters in Bulletin 1-VE-6. Write us.

Want a standard mount for vibration isolation in the special class?

With the Isomode* Type 17 Isolator, you not only conform to MIL-I-5432 specification but also get an unusual degree of isolation efficiency. It has equal spring rates in every direction. This means better control of all modes of motion. For details on this mount, write to Dept. 6.

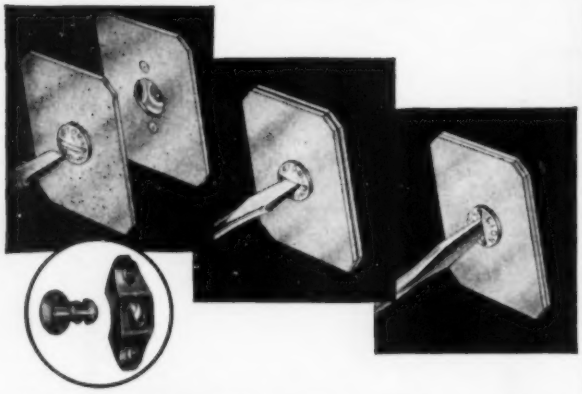
*Trade Mark Reg. U.S. Pat. Off.

THE MB MANUFACTURING COMPANY, INC.
1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION • TO MEASURE IT • TO REPRODUCE IT

For Parts that must be
TAKEN OFF–PUT BACK–BUTTONED TIGHT

LION FASTENERS



LOCKS TIGHT WITH A QUARTER TURN
Always at correct tension

Lion Fasteners are *right* for buttoning parts that must be removed repeatedly for inspection, maintenance, or other reasons.

Vibration and shock can't loosen a Lion Fastener. Even an inexperienced service man can't replace it wrong. A quarter turn opens it. Another quarter turn locks it. The tension is *designed into it.*

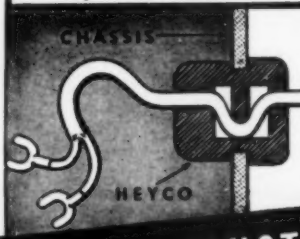
Lion Fastener Spring Assembly is quickly spot welded or riveted in place. The stud cannot be lost. It is grommeted tight to the sheet. They will button sheets .040 plus or .020 minus over or under standard rating. The misalignment is as much as .156. The one-piece forged stud is tested to 1425 lbs. Write today for demonstration kit and application data.

TYPICAL APPLICATIONS: INSPECTION PLATES • COWLING • ELECTRICAL PANELS • CABINETS • DUCTWORK

Free DEMONSTRATION KIT contains sample Lion Fasteners to help you visualize their adaptability to your product. Write on your company letterhead. No obligation.

LION FASTENERS, INC.
300 Main St., Honeoye Falls, N.Y.

Facts you should know about HEYCO STRAIN RELIEFS!
the Nylon Bushings that Anchor cord to housing



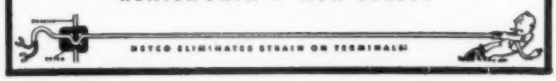
1. Absorb cord pull, push and torque
2. Insulate wire from housing

CUT PRODUCTION COSTS
IMPROVE PRODUCT QUALITY

APPROVED SA UL

SAMPLES? Send wire size and chassis information—
Try HEYCOS at no cost to you—today!
MADE IN ALL SIZES FOR CLOCK WIRE TO S-10/3 CABLE

HEYMAN MANUFACTURING COMPANY
KENILWORTH 3 NEW JERSEY



HYDRAULIC VALVES

Pathon

HYDRAULIC CYLINDERS

• WRITE today for literature covering Pathon's new Solenoid Controlled Pilot Operated Hydraulic Valves, Bulletin No. 15 and/or Hydraulic Cylinders, Bulletin No. 17.

PATHON MFG. CO.
3823 PACIFIC AVENUE
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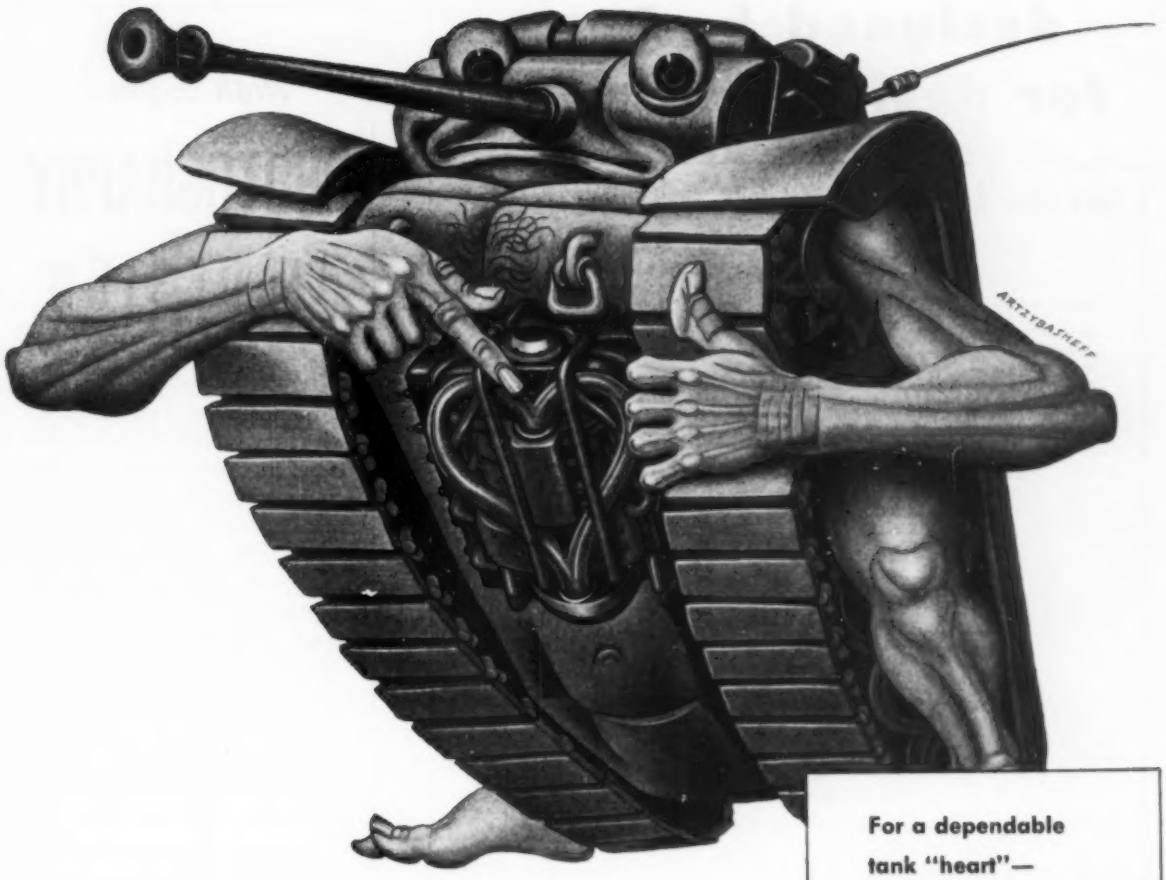

New "ticker" for tanks

Rumbling over rugged terrain . . . crushing enemy obstacles . . . surviving heavy fire—our "G.I." tanks must have powerful, dependable engines to stay "alive" in combat. That's why the Army Ordnance Corps relies on Lycoming to turn out air-cooled "tickers" for new-type tanks now in production.

Maybe you need a complete engine, or a single precision part. Maybe you have "only an idea" in the rough or blueprint stage that needs development. Or a metal product that needs precise and speedy fabrication. In *any* case—look to Lycoming! Lycoming has a long-tested reputation for meeting the most exacting and diverse metal-working requirements, both industrial and military. *Whatever* your problem—look to Lycoming!

Lycoming's wealth of creative engineering ability, its 2½ million square feet of floor space, its 6,000-plus machine tools stand ready to serve your needs.

AIR-COOLED ENGINES FOR AIRCRAFT AND INDUSTRIAL USES • PRECISION-AND-VOLUME MACHINE PARTS • GRAY-IRON CASTINGS • STEEL-PLATE FABRICATION

FOR RESEARCH · FOR PRECISION PRODUCTION

LOOK TO LYCOMING

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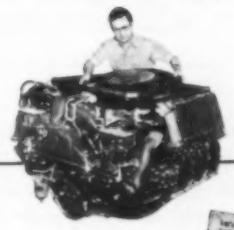
BRIDGEPORT-LYCOMING DIVISION, STRATFORD, CONN.

For a dependable tank "heart"—500 horsepower's worth of rugged air-cooled engine—U. S. Army Ordnance looks to Lycoming's precision production.



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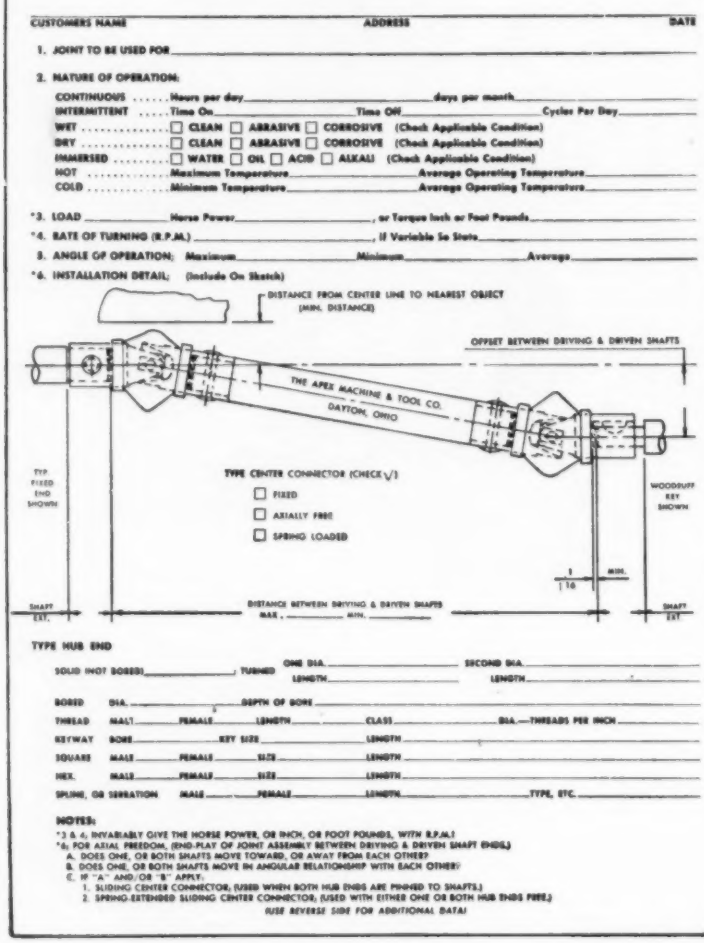
designed *by* APEX *for design engineers*

data sheet for Apex Universal Joint applications


CUSTOMERS NAME
ADDRESS
DATE
1. JOINT TO BE USED FOR
2. NATURE OF OPERATION:
CONTINUOUS ..... Hours per day ..... days per month
INTERMITTENT ..... Time On ..... Time Off ..... Cycles Per Day
WET ..... ☐ CLEAN ☐ ABRASIVE ☐ CORROSIVE (Check Applicable Condition)
DRY ..... ☐ CLEAN ☐ ABRASIVE ☐ CORROSIVE (Check Applicable Condition)
IMMERSED ..... ☐ WATER ☐ OIL ☐ ACID ☐ ALKALI (Check Applicable Condition)
HOT ..... Maximum Temperature ..... Average Operating Temperature
COLD ..... Minimum Temperature ..... Average Operating Temperature
*3. LOAD ..... Horse Power ....., or Torque Inch or Foot Pounds
*4. RATE OF TURNING (R.P.M.) ....., If Variable So State
5. ANGLE OF OPERATION: Maximum ..... Minimum ..... Average
*6. INSTALLATION DETAIL: (Include On Sketch)
DISTANCE FROM CENTER LINE TO NEAREST OBJECT (MIN. DISTANCE)
OFFSET BETWEEN DRIVING & DRIVEN SHAFTS
THE APEX MACHINE & TOOL CO. DAYTON, OHIO
TYP. FIXED END SHOWN
TYPE CENTER CONNECTOR (CHECK √)
☐ FIXED
☐ AXIALLY FREE
☐ SPRING LOADED
WOODRUFF KEY SHOWN
MIN.
SHAFT EXT.
DISTANCE BETWEEN DRIVING & DRIVEN SHAFTS MAX. ..... MIN. .....
SHAFT EXT.
TYPE HUB END
SOLID (NOT BORED) ..... ; TURNED ONE DIA. ..... SECOND DIA. .....
LENGTH ..... LENGTH .....
BORED DIA. ..... DEPTH OF BORE .....
THREAD MALE ..... FEMALE ..... LENGTH ..... CLASS ..... DIA.—THREADS PER INCH .....
KEYWAY BORE ..... KEY SIZE ..... LENGTH .....
SQUARE MALE ..... FEMALE ..... SIZE ..... LENGTH .....
HEX. MALE ..... FEMALE ..... SIZE ..... LENGTH .....
SPLINE, OR SERRATION MALE ..... FEMALE ..... LENGTH ..... TYPE, ETC. .....
NOTES:
*3 & 4, INVARIABLY GIVE THE HORSE POWER, OR INCH, OR FOOT POUNDS, WITH R.P.M.!
*6, FOR AXIAL FREEDOM, (END-PLAY OF JOINT ASSEMBLY BETWEEN DRIVING & DRIVEN SHAFT ENDS,)
A. DOES ONE, OR BOTH SHAFTS MOVE TOWARD, OR AWAY FROM EACH OTHER?
B. DOES ONE, OR BOTH SHAFTS MOVE IN ANGULAR RELATIONSHIP WITH EACH OTHER?
C. IF "A" AND/OR "B" APPLY:
1. SLIDING CENTER CONNECTOR, (USED WHEN BOTH HUB ENDS ARE PINNED TO SHAFTS.)
2. SPRING-EXTENDED SLIDING CENTER CONNECTOR, (USED WITH EITHER ONE OR BOTH HUB ENDS FREE.)
USE REVERSE SIDE FOR ADDITIONAL DATA!

Apex universal joint application data sheets are designed to help you, the design engineer. Use them to insure delivery of the exact type of Apex universal joints you specify . . . use them on standard applications to enable Apex engineers to recommend the universal joint best fitted to your needs . . . use them on special applications, to take full advantage of Apex specialized universal joint engineering service . . . use them to make your own work easier.

Apex universal joint application data sheets are included in Catalog 27—write, on your company letterhead please, for your copy.

APEX universal joints

THE APEX MACHINE AND TOOL COMPANY
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High Speed

PHOTOGRAPHY IN DESIGN

High-speed photography not only offers the designer all of the advantages generally associated with ordinary stills and moving pictures, but also puts at his disposal a means for actually studying motions and events that until recently have never been "stopped" or slowed down to perceptible speeds.

Product Engineering's Special Editorial report on this subject gives designers a thorough study of basic considerations in the field of high-speed photography, operation and characteristics of major types of high-speed cameras, and some typical fields of application.

Included with this report is a fully illustrated Chart of High-Speed Camera Systems, headed by a master diagram that shows the essential elements of high-speed camera optical systems.

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Chairman of the Board, Northrop Aircraft, Inc.

"For nearly every American, systematic saving during productive years is the best means of insuring future security. We at Northrop Aircraft believe in the Payroll Savings Plan. We feel that bond purchases contribute greatly toward keeping us free as a nation and financially independent as individuals."

In addition to a deep, personal interest in his own company's Payroll Savings Plan, Mr. Echols is Chairman of the Aircraft Industry Committee to build employee participation in the Payroll Savings Plan.

- When Mr. Echols' Committee was formed, 17 major airframe manufacturers and 11 major suppliers, employing 400,000 workers, had a total of 80,000 employees enrolled in the Payroll Savings Plan.
- At Mr. Echols' request all 28 companies agreed to conduct person-to-person canvasses among their employees.
- The first companies to complete their canvasses report a total of more than 70,000 new Payroll Savers bringing the industry total to more than 150,000 participants.
- In the first reports on campaigns, average payroll participation (companies reporting) went from 20% to 32%. Latest indications are that the average participation—all 28 companies—will be well over 50% by the time the canvasses are completed.
- It is estimated that the 70,000 new Payroll Savers already added to the Plan through the co-operation of Mr. Echols and his Committee will purchase more than 15 million dollars worth of Series E Defense Bonds during the next twelve months.

Has *every* employee of your company been offered an opportunity to enroll in the Payroll Savings Plan? If not, phone, wire or write to Savings Bond Division, U. S. Treasury Department, Suite 700, Washington Building, D. C. Your State Director will help you conduct a person-to-person canvass.

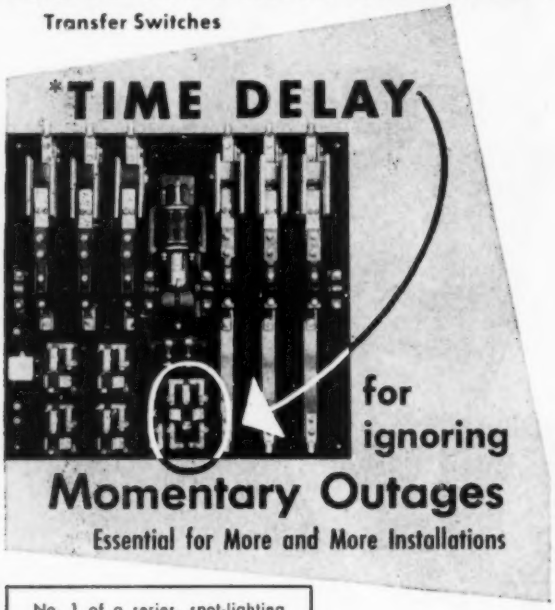
Typical Companies Reporting Results of Person-to-Person Canvasses, Payroll Savings Plan.

	Before Canvass	After Canvass
Hughes Aircraft	38.7%	85.8%
Continental Motors	10%	70%
Boeing Aircraft	17.8%	55.1%
Rohr Aircraft	1.3%	77.6%
Solar Aircraft	1.8%	60.5%
Bell Aircraft	14%	50%

The U.S. Government does not pay for this advertising. The Treasury Department thanks, for their patriotic donation, the Advertising Council and

Product Engineering

NOTE this added Feature* of ASCO Transfer Switches



No. 1 of a series, spot-lighting features to look for in adequate Automatic Transfer Switches.

We mean a "Time Delay" feature, factory set for tripping at any point between 1 and 3 seconds which permits the transfer switch to ignore normal source outages caused by transient conditions. This results in smooth handling of the connected load and reduced wear on the starting mechanisms incorporated in automatically started standby units or plants.

ASCO Time Delay can be added to any ASCO Transfer Switch you buy. It is being specified on an ever increasing scale by engineers who write electrical specifications for all types of installations.

Other ASCO design features are, of course, retained in all Transfer Switches, whether 5 or 1000 amperes or in between, as for example:

- **Phase failure relays.**
- **Double throw construction, providing positive operation and inherent interlocking.**
- **Capacity to withstand heavy inrush on tungsten lamp load... severe arcing from inductive loads ...and heating and electromagnetic effects of short time fault currents.**

We'll be glad to send details of this Time Delay feature; also the story of ASCO Service to Industry on this particular phase of Electromagnetic Controls which is given in a new booklet, "Automatic Transfer Switches", now on the press.

This Time Delay feature for ASCO Transfer Switches is but one of many developments coming from our engineering department. It gives added strength to the wide spread recognition in industry that ASCO is indeed Headquarters for Electromagnetic Controls for all types of circuits.

5.31.1

We also manufacture a complete line of "Solenoid Operated Valves" for automatic and remote control of liquids and gases. To thousands of satisfied users, "ASCO" and "Solenoid Valves" are synonymous.

ASCO Electro-Magnetic CONTROLS

Automatic Switch Co.

385 LAKESIDE AVENUE • ORANGE, NEW JERSEY

SOLVE RETAINING PROBLEMS with

SpirOlox Retaining Rings

With Spirolox you are assured of quick, easy installation and removal of the retaining ring. As illustrated by this installation on a tube-cutter assembly, Spirolox is inserted in a jiffy, removed with a flip of a screwdriver. No special tools needed.

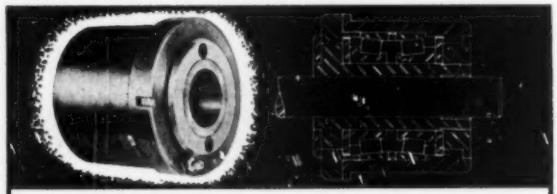
Simplified, trouble-free solutions to retaining problems like this are possible because of extraordinary Spirolox flexibility and conformability. Unique two-turn construction lets you spiral-in a Spirolox ring quickly and easily. Complete elimination of lugs or projections, breaks or gaps, provides uniform shoulder which conforms 100% to diameter of groove.

SEE OUR CATALOG IN SWEETS FOR PRODUCT DESIGNERS

FREE DATA BULLETIN tells how you can solve toughest retaining problems with SPIROLOX—send for your copy! Ramsey Corporation, St. Louis 8, Missouri, a subsidiary of Thompson Products, Inc. 108

U. S. Pat. No. 2,450,425 and Foreign Pats. Other Pats. Pend.

SPIROLOX—the Better Way to Hold Moving Parts TOGETHER!



THE ONLY PILOT BEARING BUSHING WITH ABSOLUTE SEAL AGAINST COOLANT AND GRIT!

True—absolutely true—the Jergens Pilot Bushing provides complete sealing against abrasive grits and dust or other damaging materials entering into the roller bearing cavity. Amazing as it seems the entry of grit into the outer seal actually increases the effectiveness of the seal. Furthermore, this revolutionary bushing provides greater bearing accuracy—bushing stability and the first long lasting, complete seal in the roller bearing field.

PERFORMANCE FEATURES

- Absolute seal against coolants, grit and dust
- Bearings can be dissembled without removing housing
- Cartridge-type bearing holder provides greater accuracy
- Protects against thrust loads as well as radial
- Tapered bearings can be adjusted to compensate for wear
- Adaptable to receive removable slip bushings
- Adaptable to receive keys or keyways
- Can be furnished with shafts to use as pressure rolls

SEND FOR CATALOG NO. PE-4

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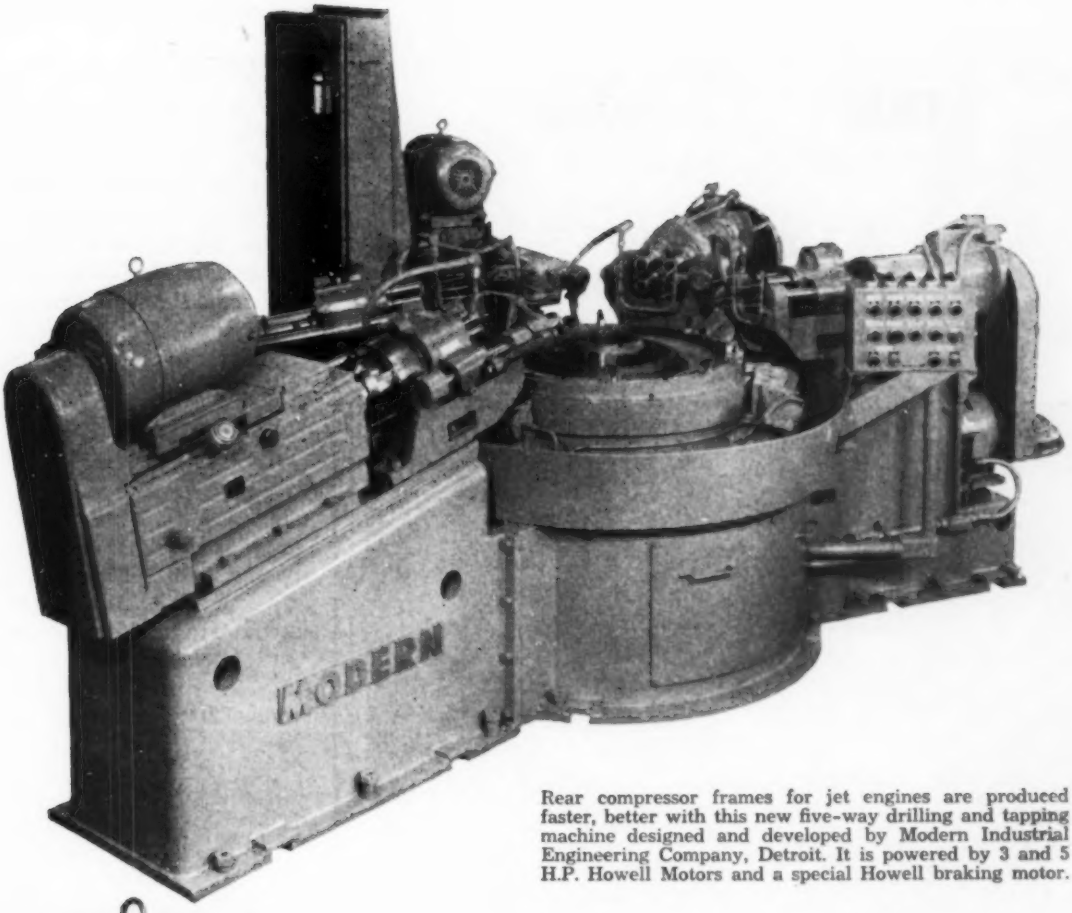
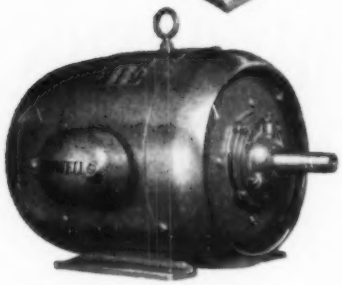
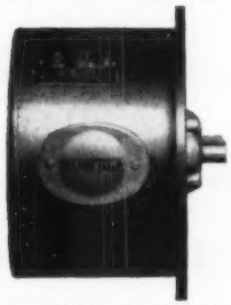


Rear compressor frames for jet engines are produced faster, better with this new five-way drilling and tapping machine designed and developed by Modern Industrial Engineering Company, Detroit. It is powered by 3 and 5 H.P. Howell Motors and a special Howell braking motor.



Howell Type K Motor. Fan-cooled; sealed against dust, dirt, fumes and moisture. Available for horizontal or vertical mounting. Sizes from 1½ to 200 H.P. at 1800 R.P.M.



Howell Disc-Type Motor. Reduces length from 41.7 to 50.5%, depending on H.P. Sizes from ¼ to 20 H.P. at 1800 R.P.M. Corresponding ratings at other speeds also available.

How Howell Motors fit into advanced machine design

Designer cites advantages of close cooperation between manufacturer and motor supplier

W. H. Bibbens, president of Modern Industrial Engineering Company, Detroit, says, "In designing special machines, we often work closely with qualified suppliers. Howell is a good example.

"On special motors particularly, Howell is set up locally, and at their factory, to assist us – both in the design and the selection of motors involving special electrical or mechanical characteristics. Quotations for these motors are always prompt, and delivery time is reasonable. The same goes for standard motors.

"All in all, we're very pleased and satisfied with the service and quality we get from Howell."

There's no reason *your* company can't benefit from Howell engineering services and precision-built motors for every application. Get in touch with the Howell man in your area, or write direct to our factory today.

HOWELL Red Band MOTORS

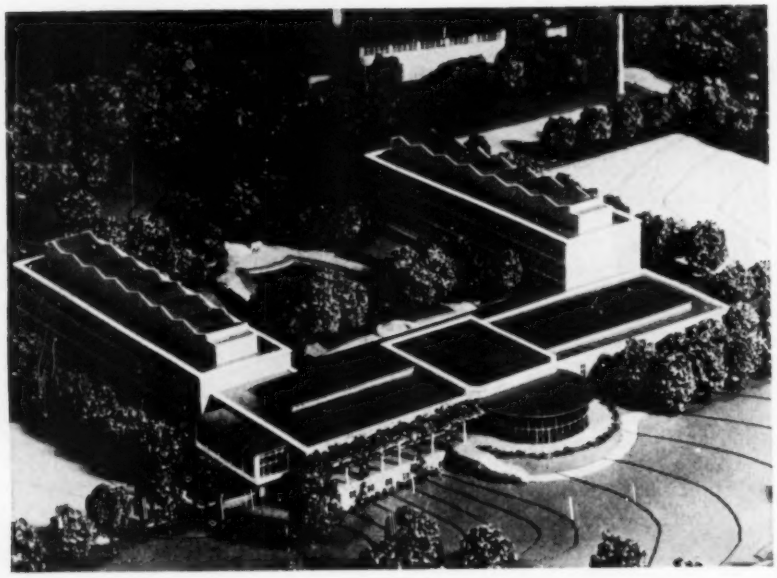
HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICHIGAN

Precision-built motors for industry since 1915

IBM *Announces*

A Great New Engineering Research Laboratory



Model of new IBM Research Laboratory now under construction at Poughkeepsie, N. Y.

In this building, ideas will be born, developed, and become part of America's future. Here, engineers and scientists will have facilities for creative work such as were undreamed of yesterday.

In IBM's other fine engineering laboratories in Poughkeepsie and Endicott, N. Y., and San Jose, Cal., engineers and scientists are working on exciting projects for the future. These include electronic digital computers, electronic and electric business machines and time systems, and electric typewriters.

IBM's continuous program of research, development, and manufacture has created a constant flow of new services for business, industry, science, and the nation.

Today there are opportunities in IBM for development engineers, physicists, and design engineers. You are cordially invited to investigate these opportunities. Inquiries should be directed to Mr. W. W. McDowell, Director of Engineering, International Business Machines, Room 166. 590 Madison Avenue, New York 22, N. Y.

TRANSPOSING an idea into a finished product involves not only the use of engineering drawings but—with form as well as function becoming increasingly important—such illustrative techniques as renderings in crayon and smootch, chalk sketches, scale and full size models, and other types of pictorial presentations.

THESE techniques, although most closely associated with the industrial designer's needs, are also useful engineering tools. Their advantages and limitations, and the methods for transposing them into engineering drawings, are fully discussed and illustrated in our Special Editorial Report . . .

THE MECHANICS of INDUSTRIAL DESIGN

Reprints available at 25¢ per copy

Reader Service Department

Product Engineering

330 W. 42ND STREET
NEW YORK 36, N. Y.

Facts about *HELI-COIL* inserts you should know

What they are

*Heli-Coil** screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

Best time to put *Heli-Coil* inserts benefits to your use is right at the designing board, as many leading manufacturers are doing. But to convince you of their many advantages ask for a working demonstration right on your production line. Write today! Complete information and engineering data is available in the *Heli-Coil* catalog. Use Coupon!

*Reg. U. S. Pat. Off.

Approved for All Military and Industrial Uses

7 savings wrapped up in HELI-COIL inserts

These savings are multiplied into major profits this simple way

Use *Heli-Coil** Inserts to:

1. *Save* money by using fewer and smaller screws to do the same holding job.
2. *Save* material—lighter bosses, thinner wall section, smaller flanges.
3. *Save* weight and reduce bulk in assemblies.
4. *Save* assembly time by using cap screws instead of nut-and-bolt assemblies.
5. *Save* rejections in production. Threads damaged on the line are quickly repaired. You save time. Reduce scrap.
6. *Save* on field service costs. No field damage to threads—fortified by *Heli-Coil* inserts.
7. *Save* customer good will by eliminating product failure due to thread fault. Every thread in your product is made stronger, longer wearing with *Heli-Coil* insert protection.

Use the handy coupon to get *free sample* Heli-Coil inserts plus all the data you need to design these savings into your product.

HELI-COIL CORPORATION
144 SHELTER ROCK LANE, DANBURY, CONN.

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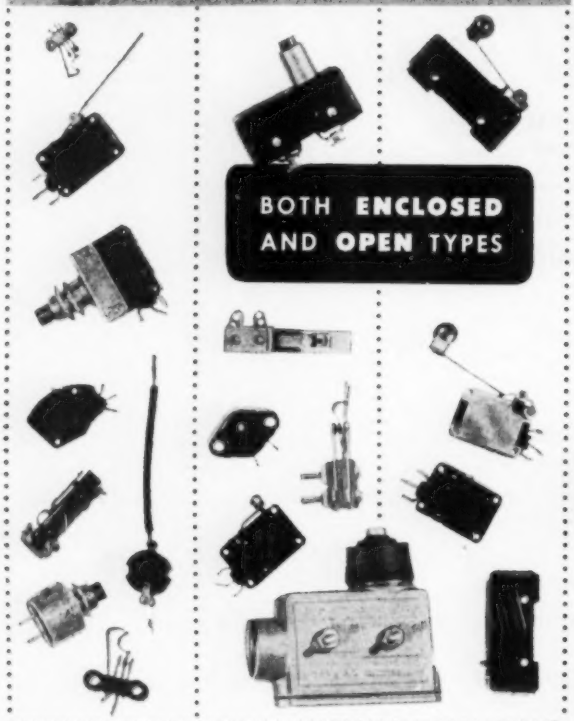

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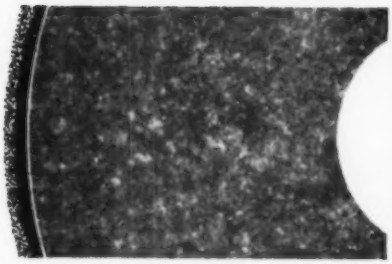
GRADUATED DENSITY

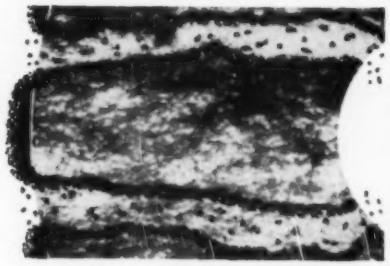
makes MICRO-KLEAN the most effective filter on the market!

How MICRO-KLEAN compares with other cartridge filters



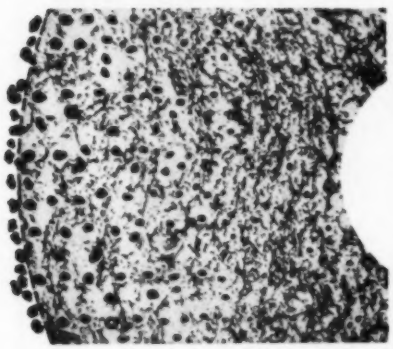
***Compare* MICRO-KLEAN with**

FILTERS WITH THE SAME DENSITY THROUGHOUT. The filter media density is the same on the pressure and discharge surfaces of the element; therefore, dirt accumulation is largely on the outside surface, choking the cartridge ("plastering") and reducing the effective filter life.



***Compare* MICRO-KLEAN with**

FILTERS WITH HAPHAZARD DISTRIBUTION OF FILTER MEDIA. Uneven haphazard media density permits fluid to find channels through the filter, and pass solids larger than the minimum filter spacing.



***Now Look* at the advantages offered by MICRO-KLEAN.** See how the fibre density increases toward the discharge side of the MICRO-KLEAN filter cartridge? In effect, every Cuno MICRO-KLEAN cartridge is an infinite multiplicity of screens, ranging from relatively coarse on the outside down to 10 microns in the center. Because of MICRO-KLEAN's graduated density in depth, particles are entrapped within the entire depth of the filter element, giving the cartridge a much longer effective life. Standard cartridge size is 9¾" long by 2¾" O. D., in densities of 10, 25 and 50 microns.

MICRO-KLEAN gives you

- **greater dirt holding capacity**
- **absolute protection against rupturing or channeling of the cartridge**
- **longer effective cartridge life**

REMEMBER . . . IF YOU CAN PUMP IT, CUNO CAN FILTER IT

M.3.C

CUNO

ENGINEERED FILTRATION

Removes More Sizes of Solids From More Kinds of Fluids

AUTO-KLEAN (disc-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound)

MICRO-KLEAN FILTER HALVES CARTRIDGE REPLACEMENT COSTS

Resin Impregnated Fibre Cartridge Lasts Twice as Long

MICRO-KLEAN's graduated density-in-depth allows greater capacity for dirt accumulation within the micronic cartridge, giving twice the effective life of an ordinary filter cartridge. Thus, cartridge replacement costs are cut in half. And the high porosity of MICRO-KLEAN permits higher flow rates, enabling you to speed up fluid processing.

Each fibre of the MICRO-KLEAN filter is positively bonded in position by resin impregnation and polymerization. This provides great structural strength and complete protection against channeling, rupturing, shrinking or distortion.

Cuno's exclusive method of felting fibres permits precision control of the cartridge structure, assuring MICRO-KLEAN users of consistent, uniform filtration.

MICRO-KLEAN's low pressure drop operation permits full-flow service on gravity, low pressure, or suction lines—with no loss in operating efficiency.

Try a MICRO-KLEAN cartridge in your replaceable-element type filter. Standard sizes fit many types of industrial filters now in use. Special lengths of MICRO-KLEAN cartridges can be supplied for built-in installations. MICRO-KLEAN cartridges also come in a wide range of Cuno housings.

Take advantage of Cuno's unique "money-back" offer: if MICRO-KLEAN doesn't outperform any filter cartridge you have previously used, we'll send you *double* your money back. Send coupon today for MICRO-KLEAN bulletin.

M.3.1

Cuno Engineering Corporation
Dept. 301C South Vine Street, Meriden, Conn.

I'm interested in your "money-back" offer. Please send me bulletin on Cuno MICRO-KLEAN.

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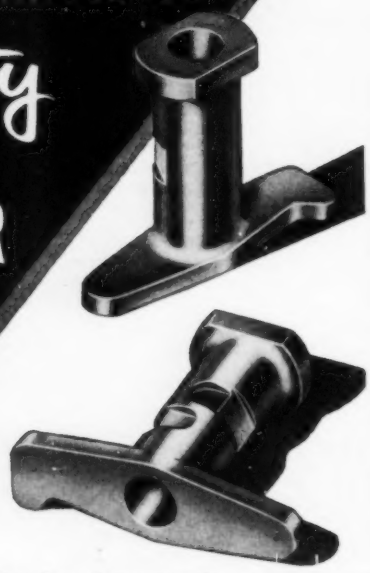

Torque Tube for Gyroscopic Application Investment Cast from S Monel ACTUAL SIZE

Mr. J. B. Lyons* tells us that in the pilot construction stages this torque tube was fabricated in two parts, the flange and the tube and then they were brazed together. Then Hitchiner Precision Investment Castings entered the picture. The resultant saving in turning, profiling, milling, drilling and boring and the elimination of the brazing meant a tremendous saving in cost . . . AND as Mr. Lyons says: "All this has been accomplished without sacrifice of quality."

*Mr. Lyons is Purchasing Agent of the Doelcam Corp., Newton, Mass.

This free folder tells you more about Hitchiner Precision Investment castings . . . send for it today

HITCHINER Manufacturing Company, Inc.
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Representatives in principal cities.

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. . . Whose one job is to expedite delivery of your requests for "New Catalogs and Bulletins" to the manufacturers concerned.

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The ACEC Motors already in use have earned a world-wide reputation for mechanical and electrical excellence. They are sold and serviced in 50 countries throughout the world—a fact which makes ACEC Motors particularly valuable on your equipment for export.

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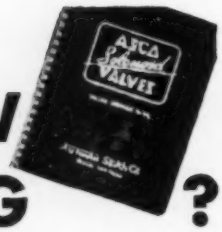


NEW ASCO CATALOG

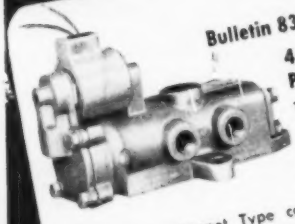
Describes Scores of Solenoid Valves

New Valve Catalog No. 24 brings you up-to-date on the extensive ASCO line of Solenoid Valves (list prices are included). New valves developed and put on the market recently are described in detail *for the first time*. A few of these are:

Bulletins 8262 and 8314
Midget Size
2 & 3-Way Packless Solenoid Valves

Midget Valves are now available with EXPLOSION-PROOF Solenoids for Class 1, Group D hazardous locations.

2-Way (Normally Open or Normally Closed) — Ports, 1/16" through 3/16"; pressures up to 1000 p.s.i. 3-Way — Ports, 3/64" and 3/32"; pressures up to 125 p.s.i. Time Delay Feature — Valves with 3½-6½ seconds delay also available.



Bulletin 8344
4-Way POPPET TYPE Packless Solenoid Valves

This valve has been thoroughly tested as a control unit in equipment requiri ng "plus" performance. Valve features:

Reliability — Poppet Type construction means this valve will not stick! Power stroke occurs in both directions — no spring return!

Fast Operation — 500 cycles/minute continuous duty; 750 cycles/minute intermittent duty (air).

Freedom in Mounting — Can be mounted in any position. Available 4 and 5 port; flow metering; standard or manifold mounting; ⅜, ½, ¾, and 1 inch pipe size. Handles air, water, or hydraulic oil; maximum pressure 250 p.s.i.

These two are just examples of new valve data. If you have *any* need for controlling the flow of liquids or gases in the equipment you are designing or operating, you should find this up-to-date ASCO Valve Catalog useful. Want a copy? Just drop us a note or call up and let us know. We'll be glad to send it to you . . . and extras for your associates if you desire.

ASCO Solenoid VALVES

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U. 53.1

Automatic Switch Co.

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A good coolant pump plus a good machine tool = FASTER, BETTER PRODUCTION FOR YOU

Photo Courtesy Boye & Emmes Machine Tool Co.

This Boye & Emmes Heavy Duty Engine Lathe is equipped with a Ruthman Gusher Coolant Pump.

RUTHMAN GUSHER COOLANT PUMPS

Gusher Coolant Pumps are designed to give you years of dependable service.

They are simple in design, have pre-lubricated heavy duty ball bearings, no metal-to-metal contacts within the pump housings, and are electronically balanced to assure you of low maintenance cost and long life. Write us today, there's a Gusher to fit your requirements.

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For your products requiring flat-type power springs . . . you should look into the opportunity to improve performance and give longer operating life with use of Sandsteel "crosscurved" mainsprings. Because of their concave-convex curvature they deliver DUAL POWER . . . smoother, more even release of energy and longer run.

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WITH increased production and higher capacities becoming the watchword, horsepower requirements are constantly increasing, too. And where high horsepower ratings and dependable service are musts—you can count on Louis Allis. The Louis Allis motor line is also unusually complete in large motor sizes, 250 to 1000 horsepower.

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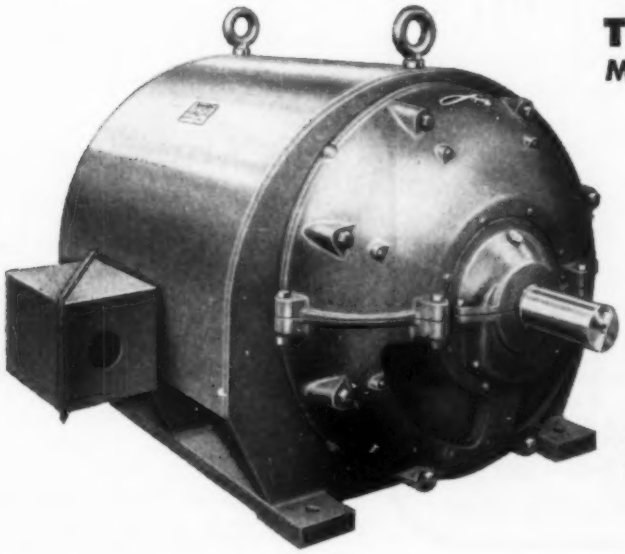
Louis Allis large motors are available in a variety of sizes, types, and enclosures. If you have applications where rugged service requirements must be met, your Louis Allis Sales Engineer will give you complete information.



700 H.P. Type OGX
3550 R.P.M. 4160 Volt
Open Drip-Proof Motor

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SM-101

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Plain • Gusseted

We will be happy to quote you prices and delivery dates on any quantity of Polyethylene flat tubing, plain or gusseted, in widths from 2" to 38" and in thicknesses from .00125 to .006. Try H & R and discover why many of the leading packaging concerns enjoy dealing with H & R for all their flat tubing needs.

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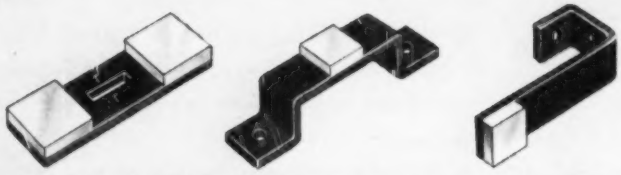


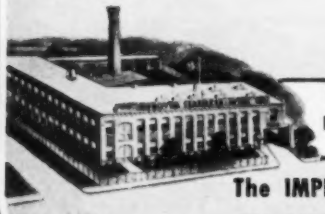
Use "IMPROVED" Silver-facing for speed, quality, durability!

We are equipped to render rapid, dependable service in brazing silver or other non-ferrous metals to your pre-shaped contact parts.

Consult us also for any problem concerning wire, sheet or tubing where a composite material, i.e. silver-copper, gold-nickel, copper-iron, etc., is desired.

Your inquiries will be appreciated and replied to promptly.

You are cordially invited to visit our booth #215 at Basic Materials Exposition, Grand Central Palace, New York City, June 15 through 19.



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INCORPORATED 1898

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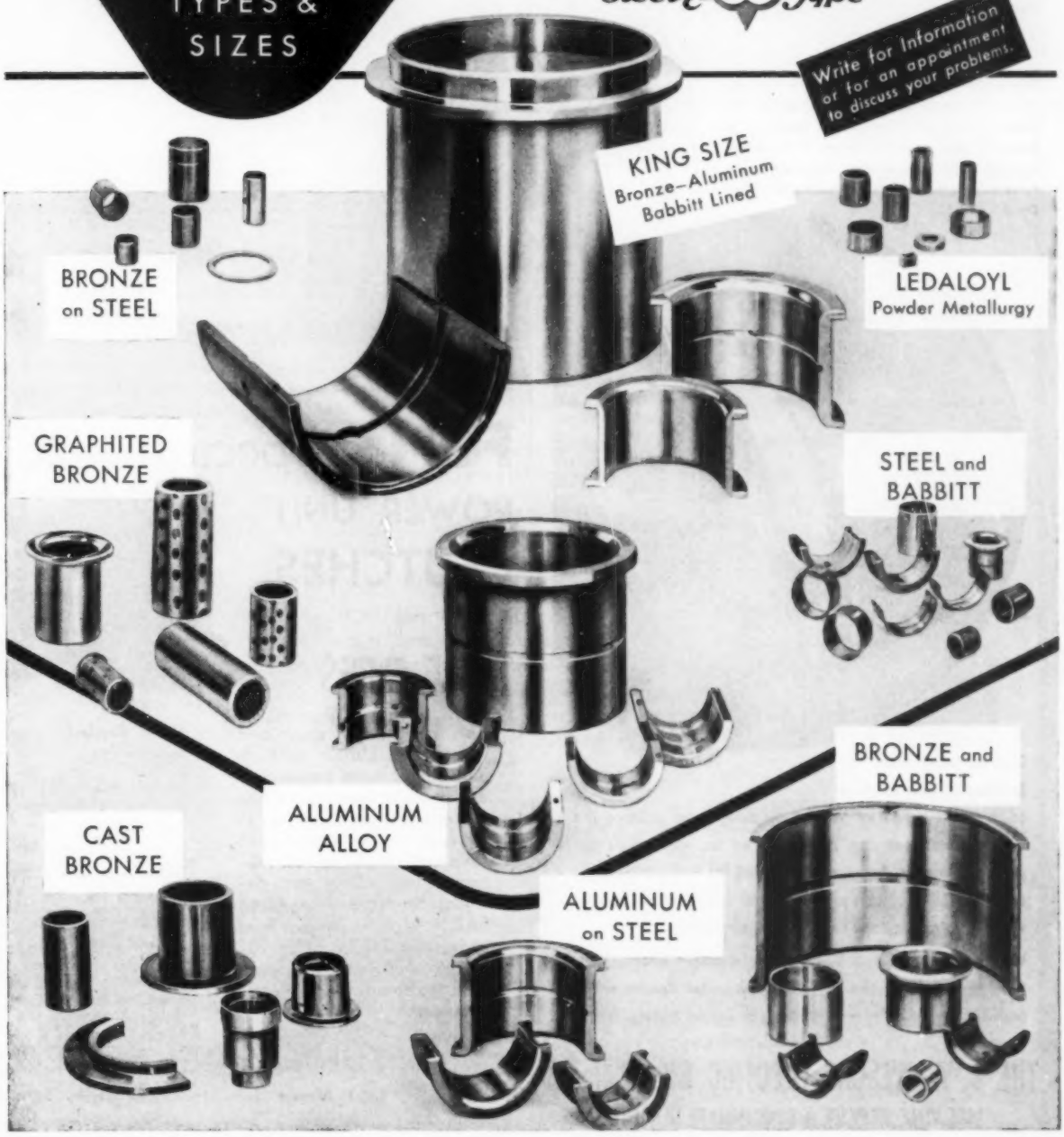
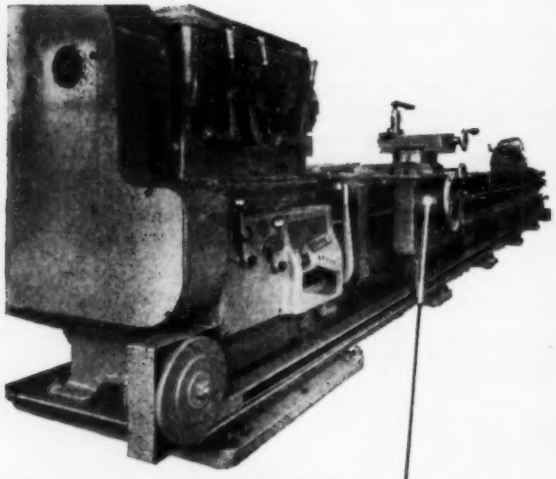
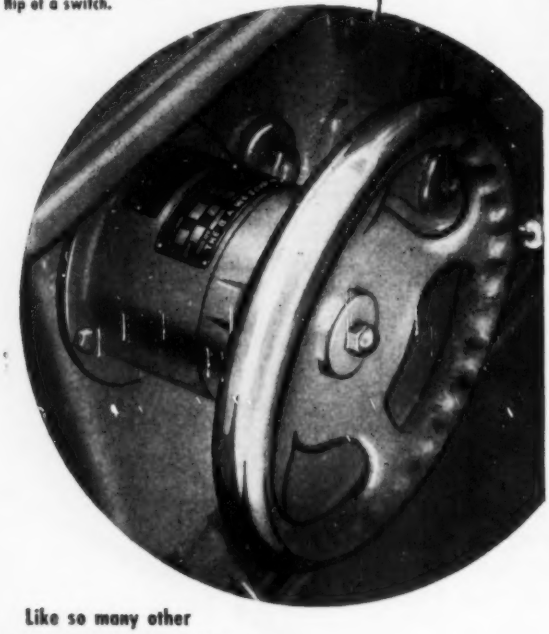
JOHNSON JB BEARINGS
Sleeve-Type

Write for Information or for an appointment to discuss your problems.





This is a 36" Series F heavy duty engine lathe, one of the fine precision machines produced by The Nebel Machine Tool Company of Cincinnati. A feature of this long bedded beauty is the power operated Rapid Traverse which moves the heavy apron quickly and surely in either direction at the flip of a switch.



Like so many other builders of fine machine tools Nebel called on Wesche to design and produce the torque motor that puts the power on the spot where the power is needed. Specifications called for ½ h.p., 3 phase, 60 cycle, 220/440 volt with a special mounting and special winding to provide the exact torque required.

Wesche Special Motors begin where standard motors stop. Send for catalog outlining our custom motor service which includes data form for easy ordering of special motors. Write:

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NOW you can give your instrument panels distinctive appearance – as well as greater convenience and accuracy – with the new easy-to-read RA Precision DUODIAL...

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The precision "feel" and handsome appearance of the RA DUODIAL–recessed black numerals on satin chrome dial with non-metallic parts of black nylon–add quality and distinction to the finest instrument panels.

The new turns–indicating MODEL RA *Precision* Duodial

See one... try one... get complete details on the Model RA Precision DUODIAL from your nearest HELIPOT representative. Or write direct!

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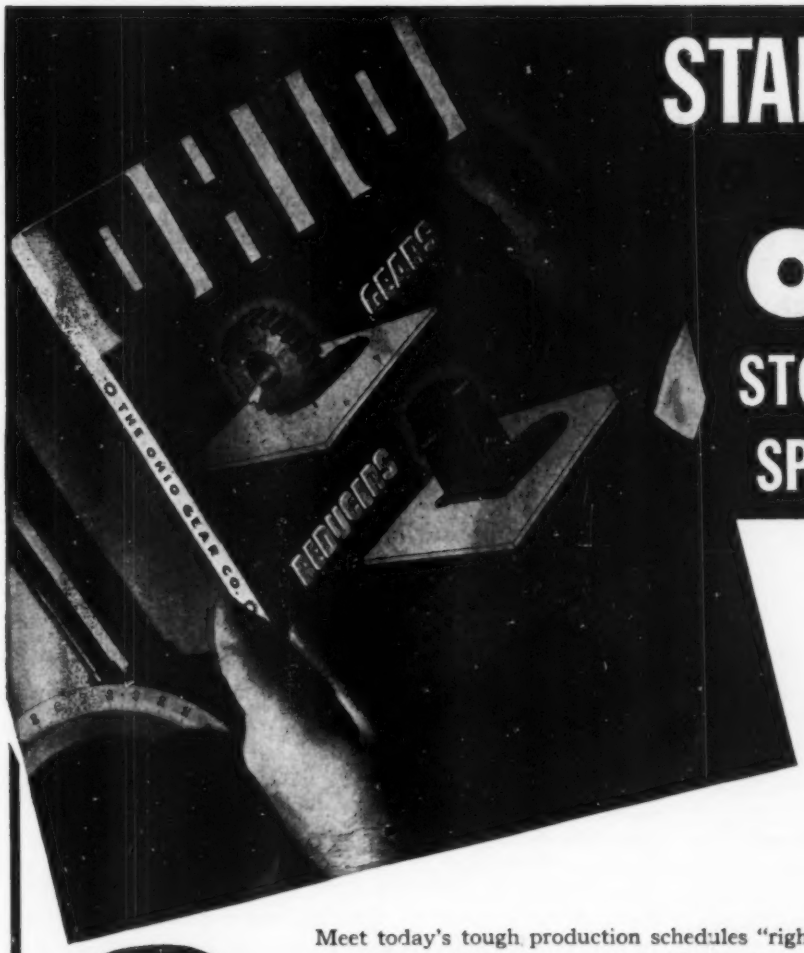
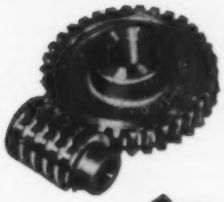
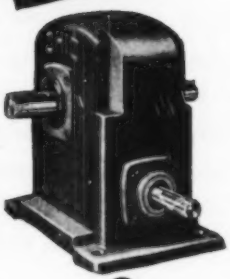
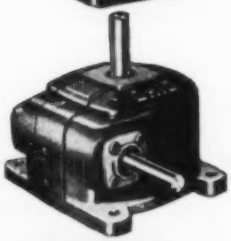
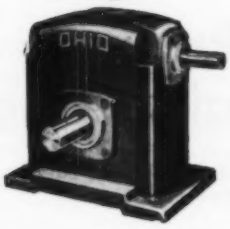


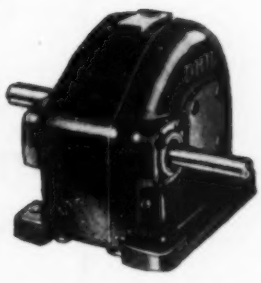
STANDARDIZE WITH OHIO STOCK GEARS AND SPEED REDUCERS











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THE COMPANY

The Hughes Laboratories, located in Southern California, are presently engaged in the development and production of advanced radar devices, electronic computers and guided missiles.

THE OPPORTUNITIES

Opportunities are offered for men who will perform interesting work on development of intricate new devices in close association with outstanding scientists. Activities will embrace a variety of challenging problems requiring originality and affording unusual possibilities of progress in learning.

FIELDS OF WORK

The work includes such fields as those involving Servo Mechanisms, Computers, Microwave Tubes, Pulse Circuitry, Solid-State Physics, Miniaturization, Antennas—Waveguides, Heat Transfer, Hydraulics—Gyros, Test Equipment, Subminiaturization, Stress Analysis, Instrumentation, Structures, and Precision Production Mechanisms.

YOUR FUTURE

Working experience in advanced techniques employing the above fields will increase your value to the Company as it further expands in development of electro-mechanical devices. Large-scale use of electronically controlled systems in business and industry is a certainty within the next few years.

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SCIENTIFIC AND ENGINEERING STAFF
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HOW TO PLAN PRODUCT COLORS

8 pages—20 cents a copy

Howard Ketcham, well-known industrial designer, has developed color and design themes for over 500 products and packaged items ranging from household appliances to locomotives. In this *Product Engineering* report he discusses the principal factors involved in matching color with product function, sales and advertising appeal, maintenance considerations, worker efficiency, safety, and size effect.

Copies of other reports in *Product Engineering's* series of full-color articles covering product improvement through better surface appearance and protection are also available. Write for an editorial reprint order form, listing titles and costs.

READER SERVICE DEPARTMENT

Product Engineering

**McGraw-Hill Building,
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Faster Stronger and Surer!

That's the unique RB&W SPIN-LOCK Screw

Assembly is faster . . . no washers are needed, and SPIN-LOCK drives easily, even in hard-to-reach spots. No special handling is necessary; screws can be hopper fed. Purchasing takes less time . . . for there's just one requisition to fill. Inventory-taking is faster . . . for there's just one part to stock.

You save all this time because RB&W's new SPIN-LOCK Screw is complete in *one piece* . . . with *exclusive* ratchet-like teeth under the head that lock into the surface, hold tighter than conventional fasteners under vibration.

SPIN-LOCK gives stronger and surer assemblies . . . its heat-treated strength enables it to exert greater clamping force . . . teeth on outer edge of head give additional locking action. Hex, pan, truss, flat heads.

Write to Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y., for SPIN-LOCK Screw folder containing complete data and specifications.

RB&W—The Complete Quality Line. *Plants at:* Port Chester, N.Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Pittsburgh, Detroit, Chicago, Dallas, San Francisco. *Sales agents:* Portland, Seattle. Distributors from coast to coast.

B.3.1

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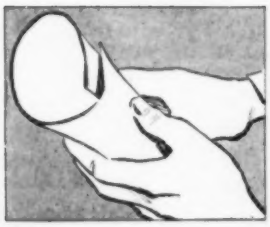
Spin-lock

U.S. Pat. No. 2,253,241

The Tighter, Stronger, Surer Fastener!

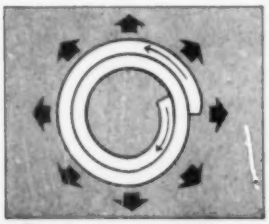
108 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

SPIRAL SPRING COILS MAKE SPIROL PIN

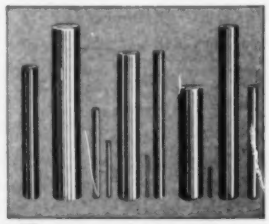


1 Roll a piece of paper spirally into a double coil. This is the way SPIROL PINS are rolled of steel or other flexible materials.

2 Compress roll and insert into circle of thumb and forefinger. Note "live action" as it expands to lock itself in circle. This is the SPIROL PIN principle.



3 When compressed by insertion, SPIROL PIN immediately develops evenly distributed radial tension, holding it firmly in place.



4 Standard SPIROL PINS from 1/32" to 1/2" diameters, and 1/8" to 4" lengths. Non-standard diameters, lengths & materials available on order.

The all-around tension provided by spiral coils gives SPIROL PIN unique fastening properties. Radial spring action locks SPIROL PIN in place . . . eliminates close tolerances . . . allows easy removal and reuse of pin. The design provides an infinite range of controlled variations in shock and shear resistance, insertion pressure, and flexibility.

FREE! Write for illustrated folder and sample SPIROL pins.

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THE Model 10VA, shown, is one of eight models of All American Vibration Fatigue Testing Machines. The "10VA" produces vibration vertically in simple harmonic motion — from 10 to 55 cycles per second on automatic control and from 10 to 60 c.p.s. on manual control. Table load capacity 10 lbs. at 10g. Has 50% overload factor. Tests components, assemblies, products — exposes danger points — forestalls failures in the field. Simple to operate. Essential for today's inspection, testing, research. Send for Bulletin 551.

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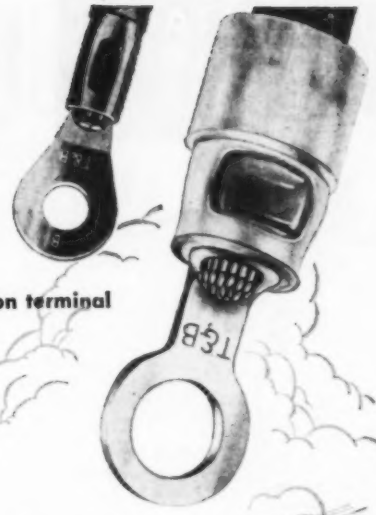
T&B ENGINEERED

Sta-kon terminal

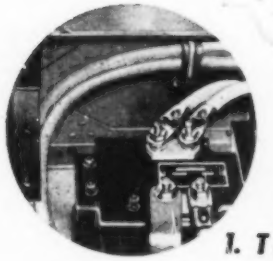
Self-insulated Sta-kon terminal



How T&B Sta-kon® terminals improve wiring performance

2. . . . they resist corrosion

Installed Sta-kon terminals have no voids that permit interior attack from corrosive agents or atmospheres. The wire strands and terminal barrel are compressed into a solid mass of exceptional conductivity. Radar, TV and other electronic applications show fewer operational failures when Sta-kon terminals are specified.



1. T & B Sta-kon terminals will not vibrate loose

Fully approved for military aircraft use, Sta-kon terminals offer permanent, mechanically-strong electrically-sound connections. T & B staking tools provide contact pressures between barrel and wire approximating 40,000 p.s.i. Physical design of the T & B stake mark is such that it cannot be pushed out . . . the barrel never relaxes its pressure on the wire. Millions of Sta-kon terminals have efficiently withstood the buffeting and vibration of near-sonic jet fighter speeds.

3. . . . they prevent accidental shorts

Self-insulated Sta-kon terminals prevent metal-to-metal contact between crowded or over-lapped leads. Color-coded nylon insulation can't slip loose . . . withstands heat, cold, oils and gasoline. A single operation with T & B Shure Stake Tools *simultaneously* stakes terminal to wire with terrific pressure, and keeps the insulation permanently in place.

For complete information on the complete line of T & B Sta-kon terminals and connectors, write for Bulletin #61.

LOOK FOR THIS SIGN — T&B ENGINEERED

IT'S THE MARK OF AN AUTHORIZED T & B DISTRIBUTOR

The complete line of T & B fittings for conductors and raceways is sold only by recognized electrical wholesalers. It's our way of assuring you the service and savings of a friendly local source. Call him for all your electrical needs. T38

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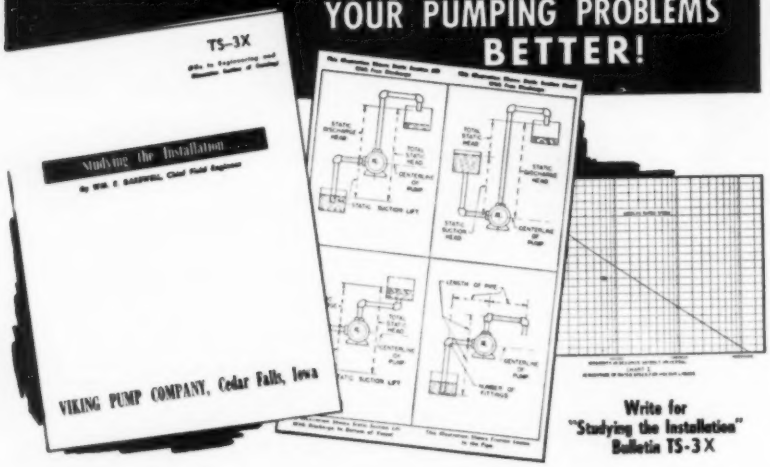

Write for "Studying the Installation" Bulletin TS-3X

VIKING AN HONORED NAME IN PUMPING

This 8-page booklet, "Studying the Installation," is yours for the asking. It contains important facts you should know and consider, when selecting the proper pump, and when making an efficient, successful pump installation.

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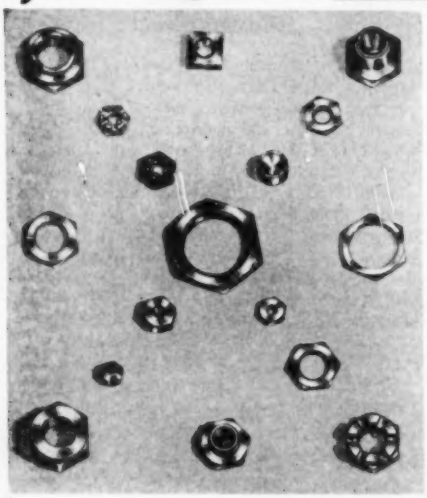

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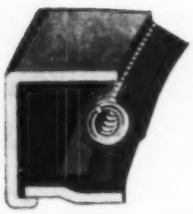
They—and their assistants—are the readers of this magazine. You can hire them by placing a "position vacant" advertisement where they are sure to see it—in our classified section starting on page 467.

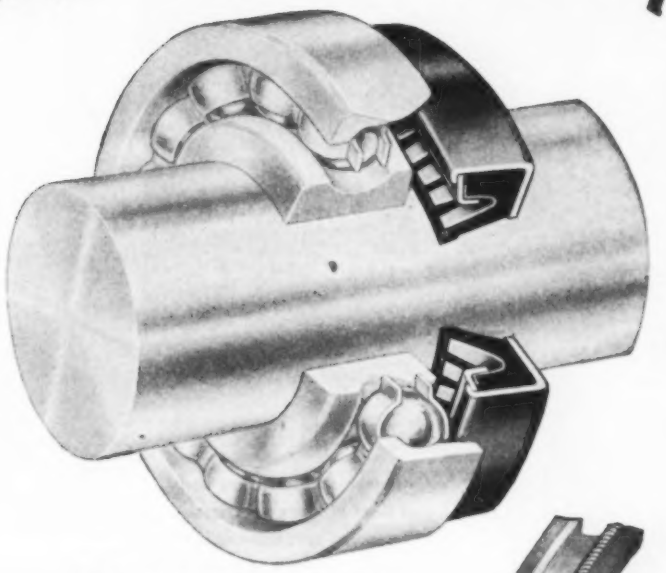
Product Engineering

To tap this manpower market, just send in your advertisement before Apr. 16 directly to us at 330 W. 42nd St., N. Y. 36, N. Y.

Best Bearing Protection Money Can Buy



Model 65—A general purpose garter spring seal for moderate speeds.



Model 53 KLOZURE applied to a shaft to protect the ball bearing.

Model 71-A—A narrow-rind springless seal for needle bearings and other limited space applications.

Model 64—A strong double spring seal for heavy duty service on large shafts.

Model 63—A general purpose finger spring seal for normal and high speed service.

Model 91-B—A narrow-rind seal with synthetic rubber outer covering for soft metal housings.

DEPENDABLE KLOZURE Oil Seals protect costly bearing installations; they prevent breakdowns and resulting losses in production. That's why many manufacturers of machine tools, gears, speed reducers, and other equipment have standardized on Garlock KLOZURES.

The standard sealing element in the Garlock KLOZURE is made of a synthetic rubber compound that is oil-resistant, non-porous and non-abrasive. Special elements, such as "Teflon" for strong acids and silicone rubber for extreme heat, are available. The metal cases are precision die-stamped.

These superior oil seals are made in a complete range of sizes and in many models; several are illustrated. *Write for KLOZURE Catalog No. 10.*

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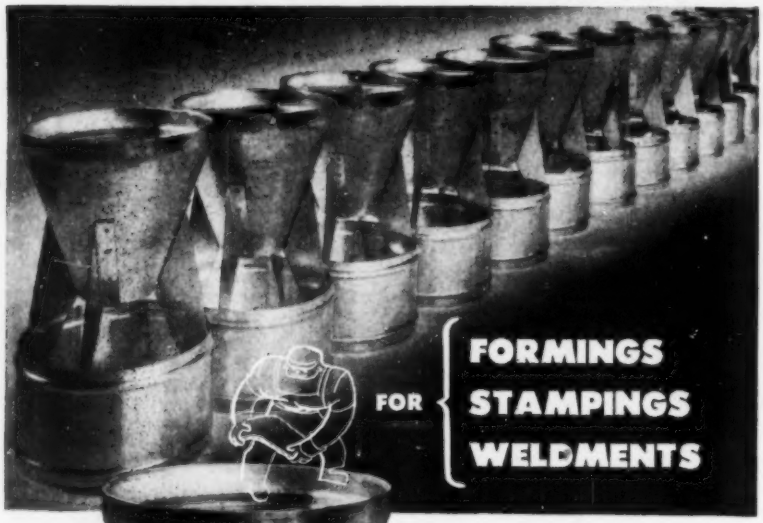
FOR ALL TYPES OF BEARINGS

BRANDT'S "BIG THREE"



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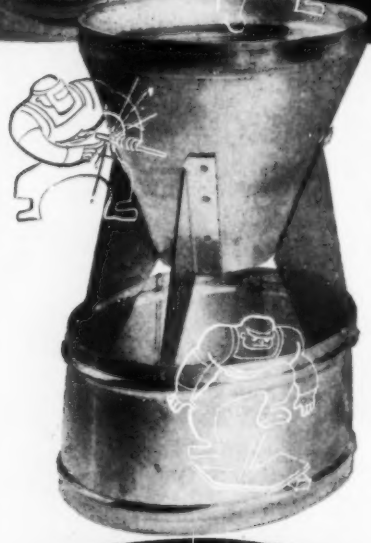

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Assembly-line scheduling saves vital *time!* Precision workmanship to exacting specifications saves *headaches!* Brandt's "Big Three" are at your disposal for any metal shape, to any size, in any metal.

The many government and industrial manufacturers who call on Brandt are highly impressed with the main plant location . . . in the midst of steel mills and major rail, water and highway transportation facilities. Brandt will be happy to place these facilities in your service.

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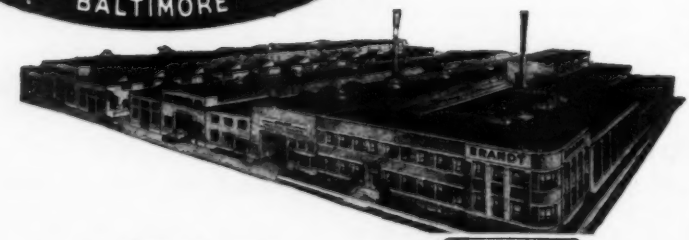

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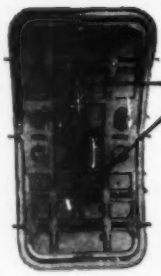

Push-pull controls conform to door contour

Plungers maintain airtight seal

Four Push-Pull Controls saved weight, engineering time and installation costs for forward passenger and cargo door of Martin 404. Four plungers operate by Simmonds controls, with two direct-line plungers on center. Bend is 90° on each push-pull, plus fit to door curvature. Maximum allowable applied load: 300 pounds.

Pre-formed, engineered controls save assembly, maintenance time . . . are lighter, cost less than alternate units. Eight similar controls used in doors of Douglas DC-6. For full data on control installations, write to:

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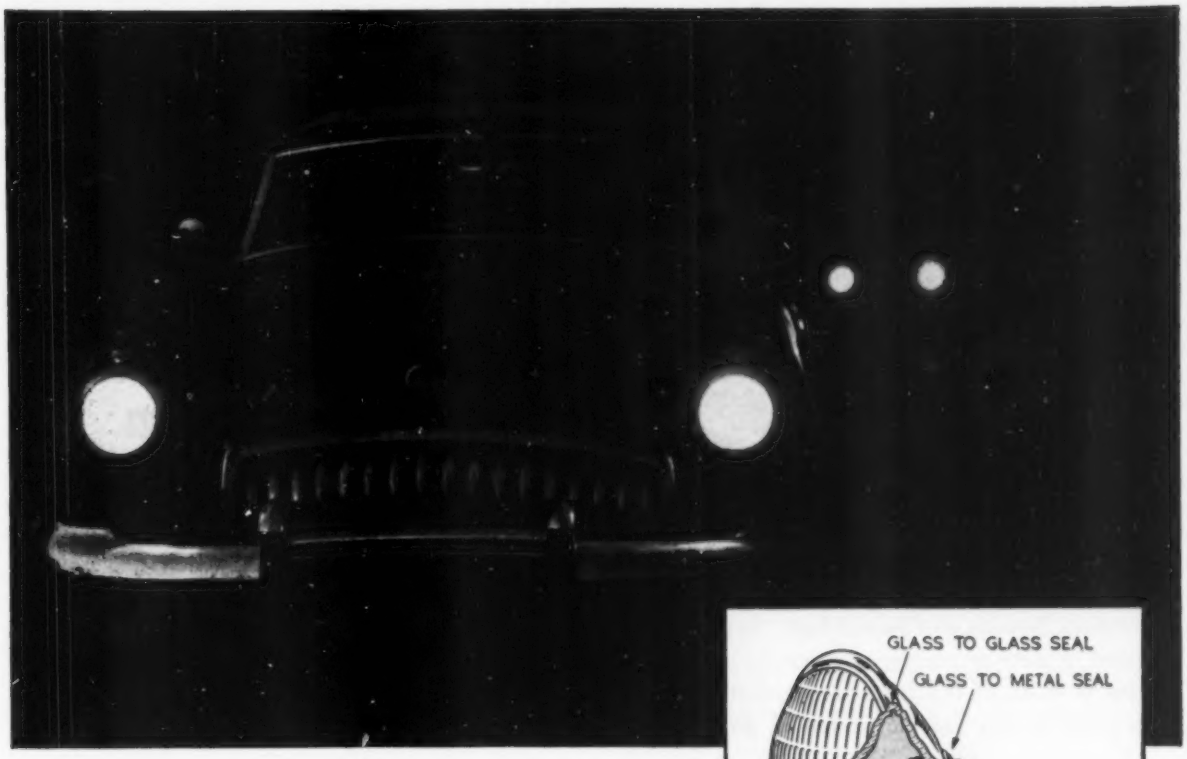

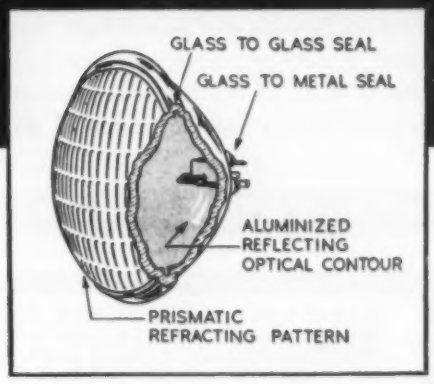

How engineered glass made night driving safer

The sealed beam headlight is taken for granted today. But it is a good example of how glass solved several tough engineering problems.

Original headlight units consisted of small bulbs which screwed into metal reflectors behind removable lenses. Accurate placement of the light source in respect to the lens and reflector was impossible. Light beams strayed—causing glare. Also reflectors corroded fast, losing as high as 35% efficiency in three months.

Lighting engineers posed these problems to Corning engineers—how to maintain the light source at a fixed point, insure an accurate parabolic reflector and make the unit airtight. Engineered glass by Corning solved all problems.

Glass could be molded to the great accuracy necessary for both reflector and lens. It also formed an ideal reflecting surface. A glass to metal seal would firmly anchor the incandescent filament directly to the reflector insuring a fixed focus. Sealing the lens and reflector together formed a hermetic seal making corrosion impossible. The unit became a self-contained precise optical system. Result—more accurate, longer lasting, safer headlights.

The technical skill applied to this problem is on call for you. If you are planning a new product or want to improve an old one, why not call Corning before you reach the blueprint stage. The literature listed below will give you helpful engineering information. Any or all of it is available on request. Mail the coupon today.

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Corning means research in Glass

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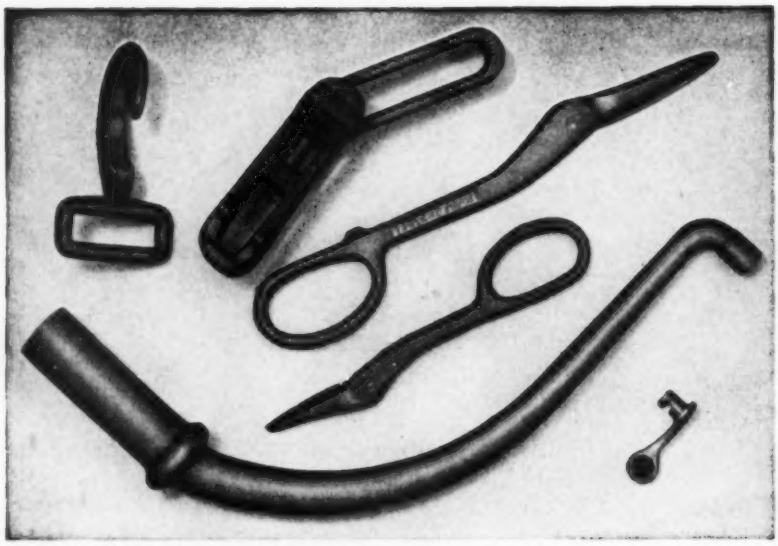

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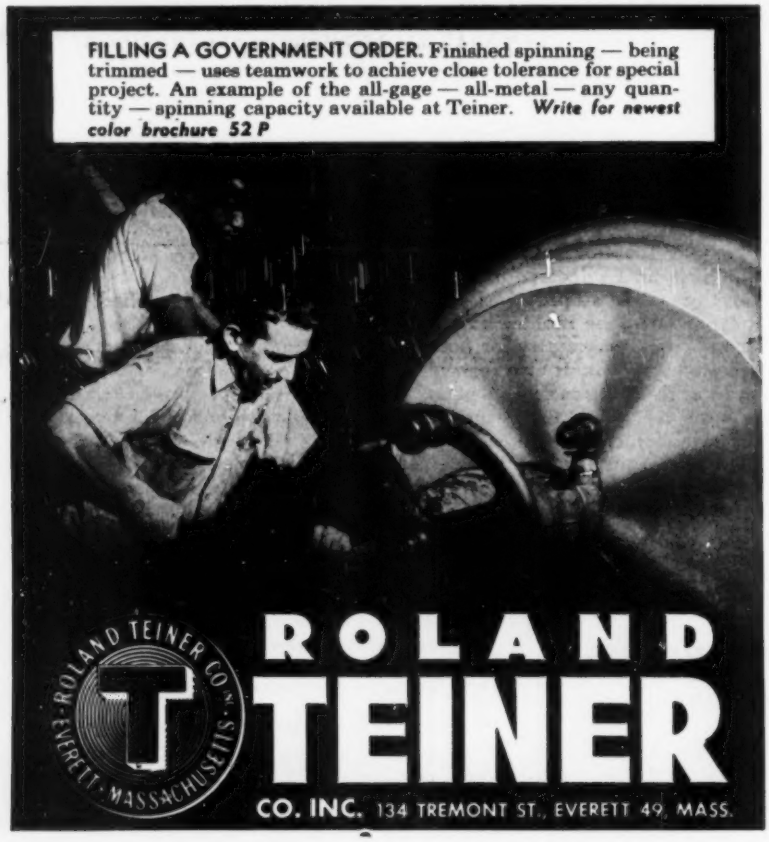
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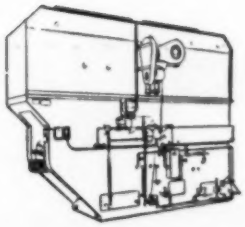

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what are your VALVE NEEDS?

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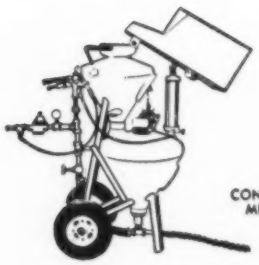
Do you have a space limitation to deal with before you select a valve? Is delivery of the automatic valves you're now using slowing down production?

If you have a pressure control valve need, here's how to fill it. The answer lies in a CASH-ACME valve . . . Or with CASH-ACME's staff of engineers who will develop just the valve to do the job you have in mind.

Mail the coupon below with a brief outline of your installation requirements. A free booklet or catalog on request.



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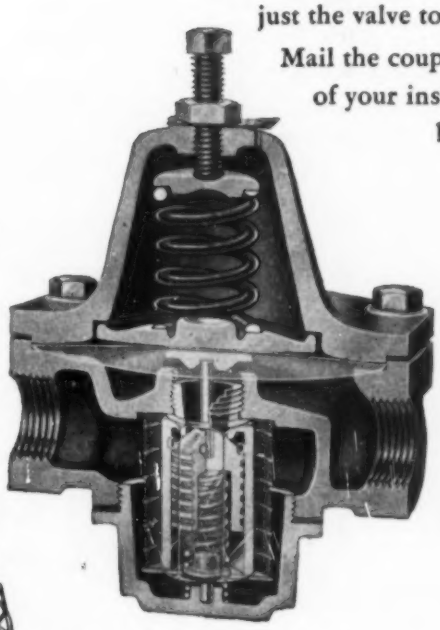

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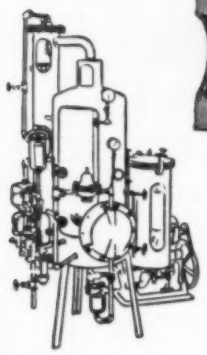
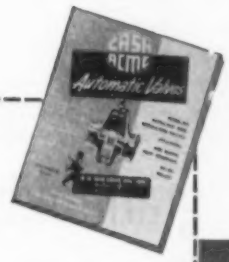


STEAM EQUIPMENT



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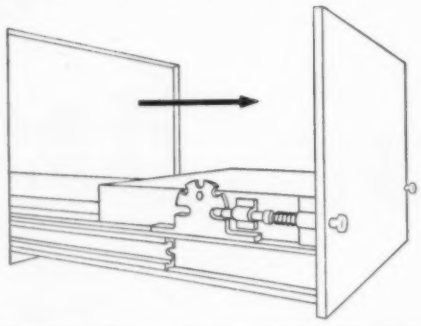

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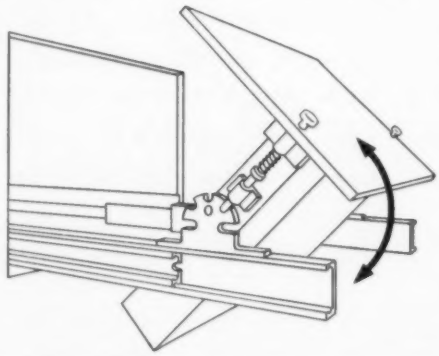

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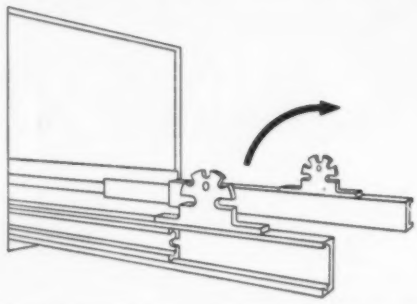

grant industrial slides

Does this kind of action suggest applications in your field? If your design problem requires sliding motion (up to 500 lbs. load) plus tilting (+90° or −90°, and any intermediate angles) plus positive locking—or any one of these—you will do well to consult "the foremost name in sliding devices." Write to Grant Pulley & Hardware Company, 31-77 Whitestone Parkway, Flushing, New York.

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EXPLOSION PROOF TYPE X5

THE new Skinner X5 Solenoid Valve is basically the same as the widely accepted and tested V5, but modified to a construction that is Underwriters' approved for Class I, Group D hazardous locations. Small size and lightweight features are retained, and the X5 is low in price because of the many parts which are interchangeable with other Skinner valves. Rating is 10 watts max.; soft, spring loaded seals prevent leakage; internal parts are stainless steel; wide variety of port locations in ⅛" and ¼" size; most types available for metering; for AC or DC in a wide range of voltages and frequencies; can be mounted in any position; supplied as two-way normally open or closed, three-way normally open, closed or directional flow. *Write today for details!*

SKINNER ELECTRIC VALVE DIV.
THE SKINNER CHUCK COMPANY
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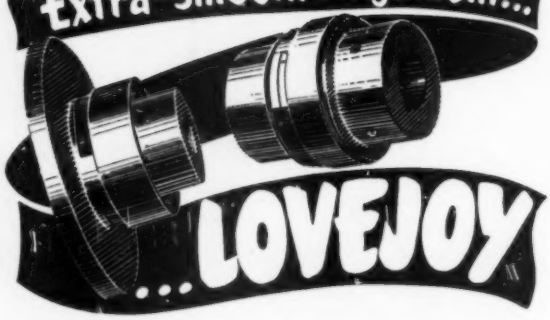

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Also Mfrs. of Lovejoy Universal Joints and Variable Speed Transmissions

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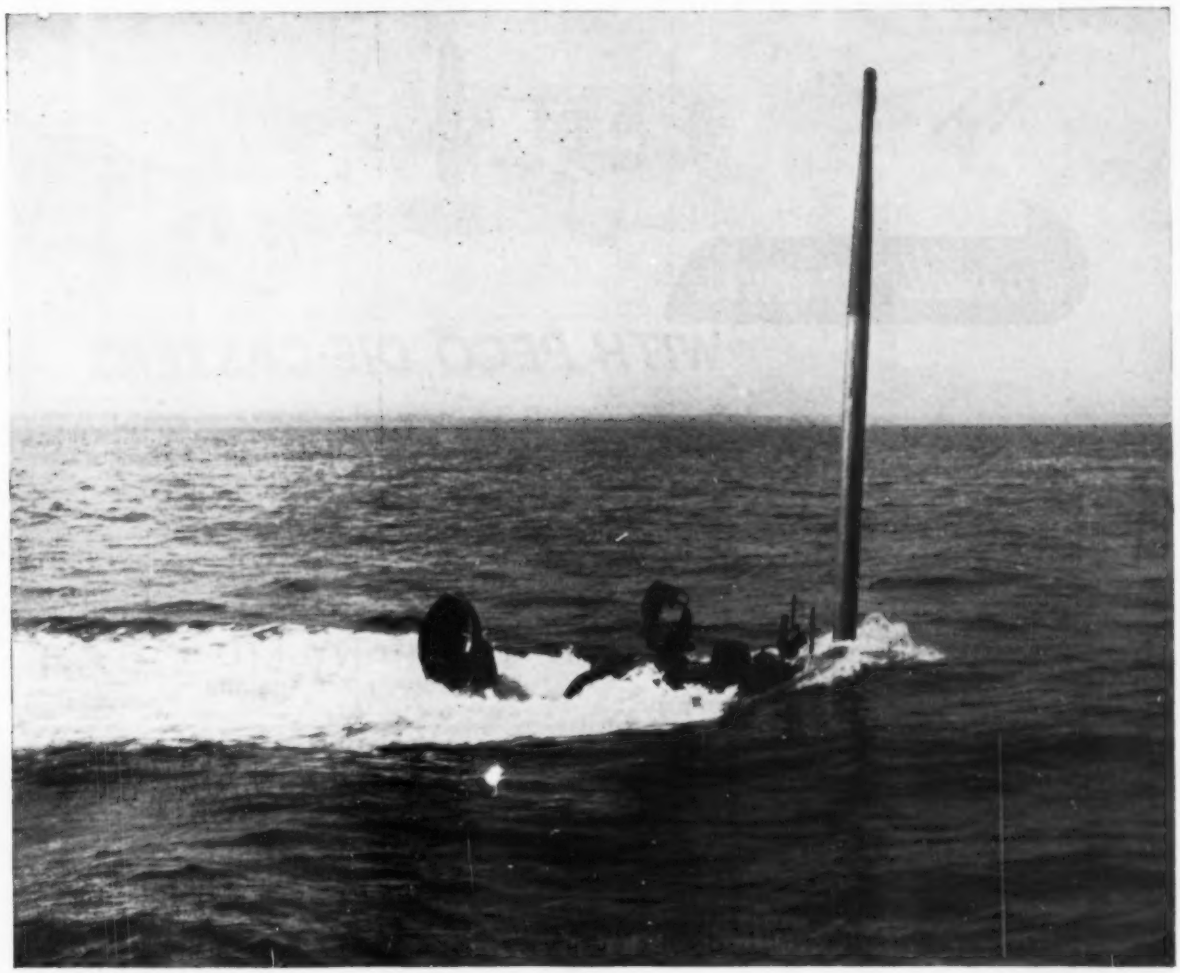

—and there's much more to it than appears on the surface

Only a stainless steel periscope tube, and some special navigational apparatus, shows above water. But below, a wonderfully compact mass of fighting machinery—literally packed with special steels and electrical alloys. *With* them, the ship is almost human. *Without* them, it has no eyes, ears, power . . . or usefulness. ● When *you* have to combat corrosion, heat, wear or great stress—or require unique electrical properties—check with us. ***Allegheny Ludlum Steel Corporation, Oliver Bldg., Pittsburgh 22, Pa.***

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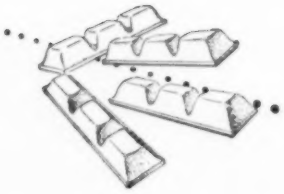
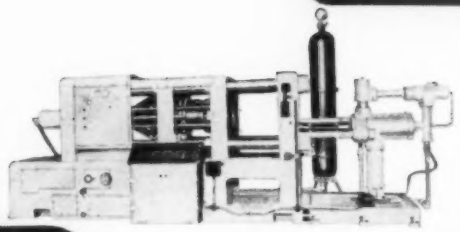
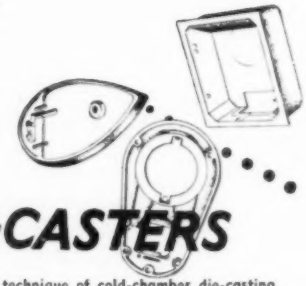


PRECISION....





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The PECO Die-Caster has four core-pulling connections, two for each platen, a built-in central hydraulic ejection cylinder and four bumper bars for mechanical ejection. All these mechanisms are fully interlocked and controlled, permitting operation in any sequence.

The central hydraulic ejector may also be used as a core-puller. This virtually increases the effective die-opening by as much as six inches, for, by withdrawing the core before parting the dies, more space is available for casting removal.

These features and many others are fully described in our brochure which we shall be pleased to forward to you on request.

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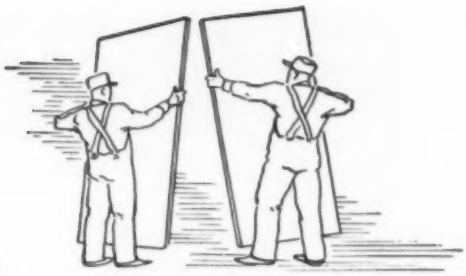


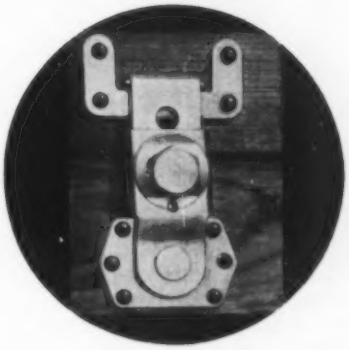
Have you a similar fastening problem?

How a strong structure can be designed for speedy and simple assembly with unskilled labor, no special tools...

The U. S. Air Force wanted a jet-aircraft hangar design that would be portable by air, yet strong; would assemble quickly; be interchangeable, and flexible enough for easy structure modification.

The answer lay in a panel structure using modular units. Armorply honeycomb panels faced with thin aluminum, developed by United States Plywood Corporation, provide lightness, strength, flexibility. Joining one panel to the other in the field with untrained help was a problem until Simmons Fastener developed LINK-LOCK, a simple latching device that operates with minimum wrench pressure on hex nut.

This fastening problem is being successfully met by combining the design ingenuity of No. 1 LINK-LOCK with the proved performance of honeycomb plywood panels.



No. 1 LINK-LOCK—like No. 2 LINK-LOCK—features simplicity, positive action, high strength.

No springs are used in No. 1 LINK-LOCK. Locking action is obtained by rotating a nut that moves a sliding latch in and out of position. Up to 1500-lb. pull-down pressure is available; the device carries up to 4000-lb. tension. No. 1 LINK-LOCKS provide for surface mounting, simplifying installation.

Where can you use it? When you need heavy fastening pressures, resistance to impact, operation in 70-below temperatures—and where ease of action, compactness, and low cost are important factors. Write for a No. 1 LINK-LOCK Data Sheet.

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Simmons

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QUICK-LOCK
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the eye...

Of course, this is an exaggerated picture. Your Meyercord Decal Nameplates have very little apparent thickness. For all practical purposes Meyercord Decals are a part of the surface or finish to which they are applied!

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The Meyercord Decal Nameplate you apply to your product is the result of vast experience and never-ending engineering improvement. Just "any" decal won't do the job. Today's multiplicity of commercial surfaces and finishes demand exhaustive pre-testing to make very sure your Meyercord Decal Nameplate lasts the full life of the product.

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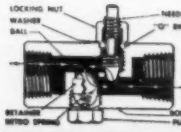

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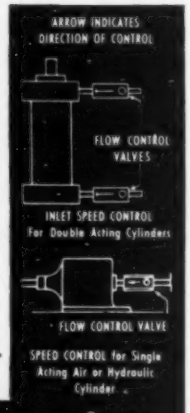
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**Walter Tydon, widely known aviation engineer and aircraft designer and veteran of 25 years in aviation, is Chief Engineer of Fairchild's Aircraft Division.*

ENGINE AND AIRPLANE CORPORATION
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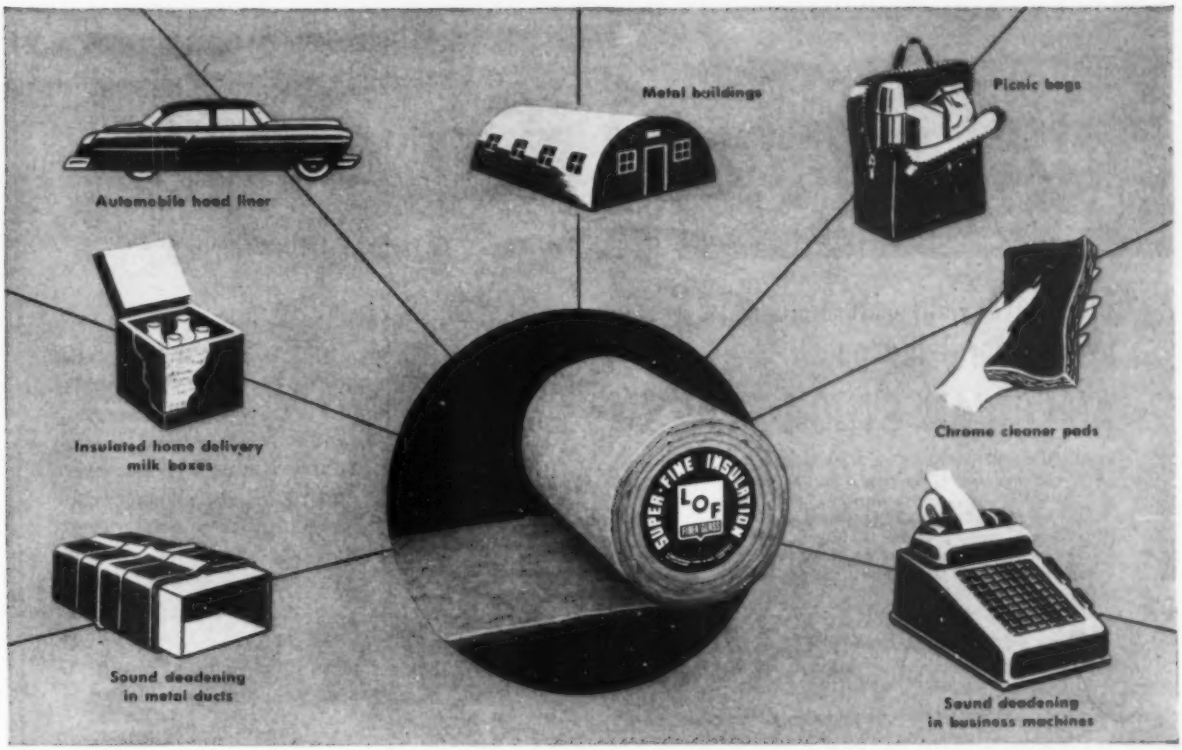

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Super·Fine is supplied in lightweight blankets. Millions of tiny glass fibers, held together with special binders, form tiny air cells. The glass fibers will not burn, mildew, rot, absorb moisture or odors, or support fungi. Only inorganic fibers, of which Super·Fine is composed, have *all* these properties. Super·Fine is a superior insulation in its resistance to heat flow.

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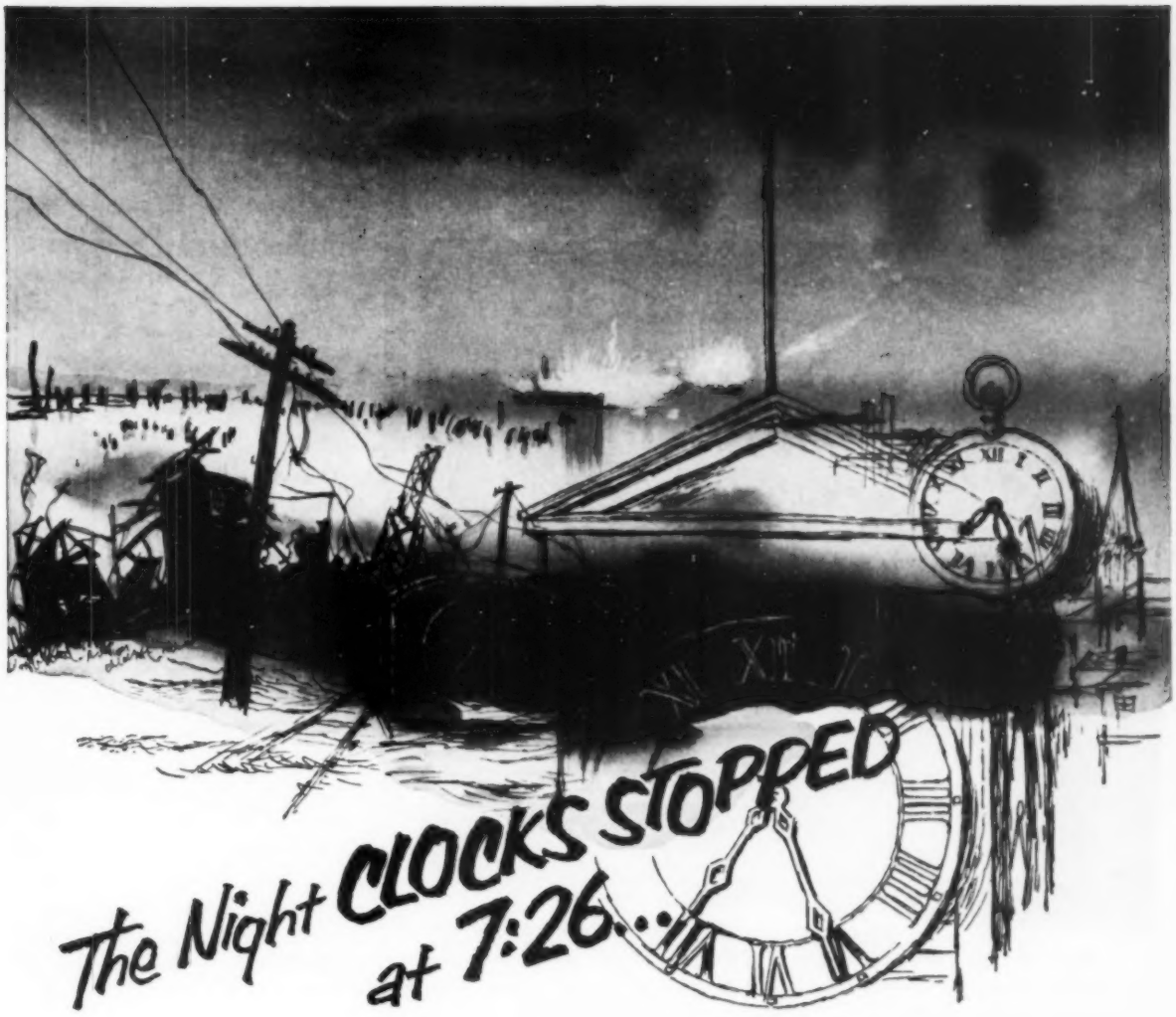

Some 9,500 people were in South Amboy, N.J., that drizzly evening in 1950. At the waterfront, longshoremen were transferring the last of 12 freight cars of ammunition to lighters that would carry it to a waiting vessel in Raritan Bay.

But the City Hall clock never got to 7:27—and the freighter's deadly cargo never got loaded. Explosions shattered windows over a radius of 12 miles; and hundreds of people looked at their arms and legs and saw that flying daggers of glass had stabbed them.

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Give Blood Now

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Business Executives!

✓Check These Questions!

If you can answer "yes" to most of them, you—and your company—are doing a needed job for the National Blood Program.

- ☐ Have you given your employees time off to make blood donations?
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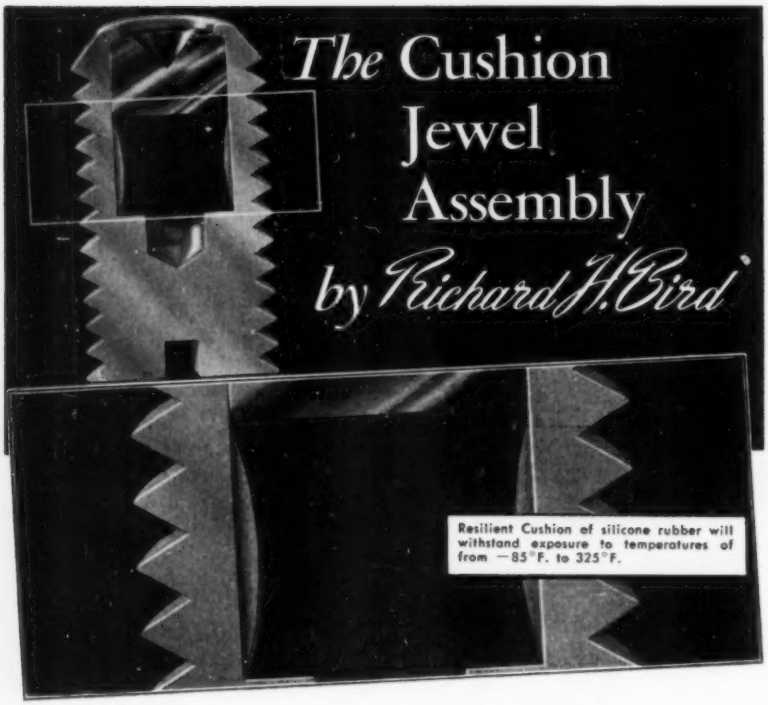
- ☐ Have you set up a list of volunteers so that efficient plans can be made for scheduling donors?
- ☐ Have you arranged to have a Bloodmobile make regular visits?
- ☐ Has your management endorsed the local Blood Donor Program?
- ☐ Have you informed employees of your company's plan of co-operation?
- ☐ Was this information given through Plant Bulletin or House Magazine?
- ☐ Has your company given any recognition to donors?
- ☐ Have you conducted a Donor Pledge Campaign in your company?

Remember, as long as a *single* pint of blood may mean the difference between life and death for *any* American . . . the need for blood is *urgent!*

...an entirely new concept of jewel mounting for shock protection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by Richard H. Bird
Resilient Cushion of silicone rubber will withstand exposure to temperatures of from −85°F. to 325°F.

Here is your answer to protection for the critical jewel assembly in meters and instruments that must withstand severe shock and vibration conditions. Tests* show that BIRD Cushion Jewel Assemblies perform better and are less subject to damage than conventionally mounted jewels.

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Bird Cushion Jewels for shock mounting

- Perform better, provide "protection"
- Variable cushioning to suit different operating conditions
- Produced in any mounting to specification
- Eliminates damage by inexperienced assemblers
- Controls movement of jewel — no loose assemblies
- Inexpensive shock-proofing for any instrument

* Tests, being conducted at the Squier Signal Laboratories, to compare cushioned and conventional mounts, show that jewels that are cushion-mounted have a better resistance to vibration. Shock tests of instruments using cushion assemblies indicate better performance and less damage susceptibility than instruments using conventionally mounted jewels.

We want to show you how BIRD Cushion Jewel Assemblies can add shock protection to your instruments. A request on your letterhead will bring complete information — or, send us specifications and sizes of jewel bearings in your instruments for samples of Cushion Jewel Assemblies for test *in your plant*.

The engineering staff of the Bird Company is at your service for *all* small bearing problems.

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The Annual HANDBOOK of Product Design for 1954 is in production

The Annual HANDBOOK of Product Design for 1954 will be ready in Mid-November. Our special *HANDBOOK* editorial staff, with the full cooperation of all other *Product Engineering* editors, is hard at work on the year-long job of selecting the most significant design-engineering data that is being published in the world's technical press this year.

Indications are that this year's edition of the *HANDBOOK* will be even bigger and more helpful to you than the *1953 HANDBOOK* about which we are receiving so many enthusiastic comments from product-design engineers everywhere.

As before, all editorial material, and related advertisements, will be grouped into ten separate sections, enabling you to locate the information you want on any specific subject quickly. Both the editorial and advertising pages will be thoroughly indexed and, in addition, the 1954 edition will carry a complete editorial index of the *1953 HANDBOOK*.

Again this year, the *HANDBOOK* will come to you as part of your regular subscription to *Product Engineering*.

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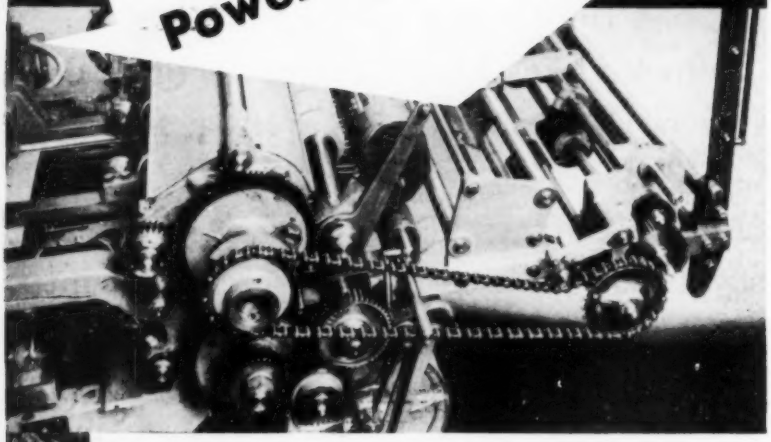

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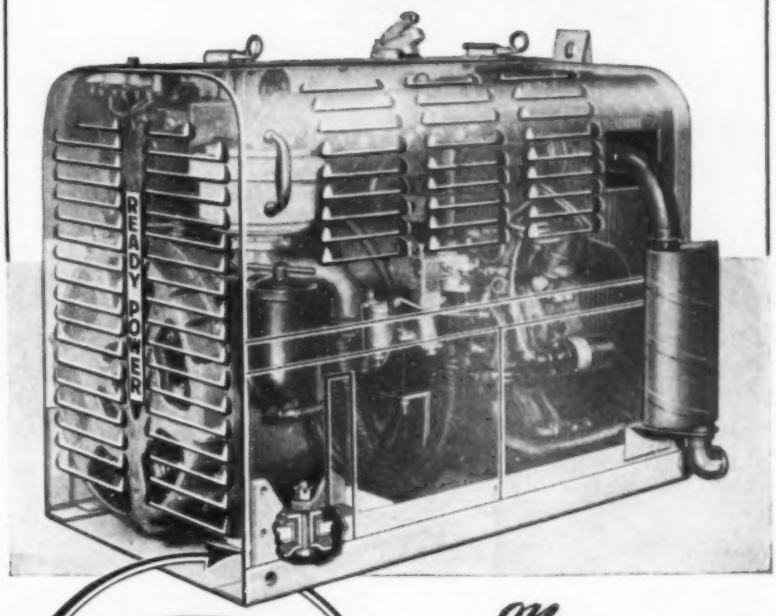

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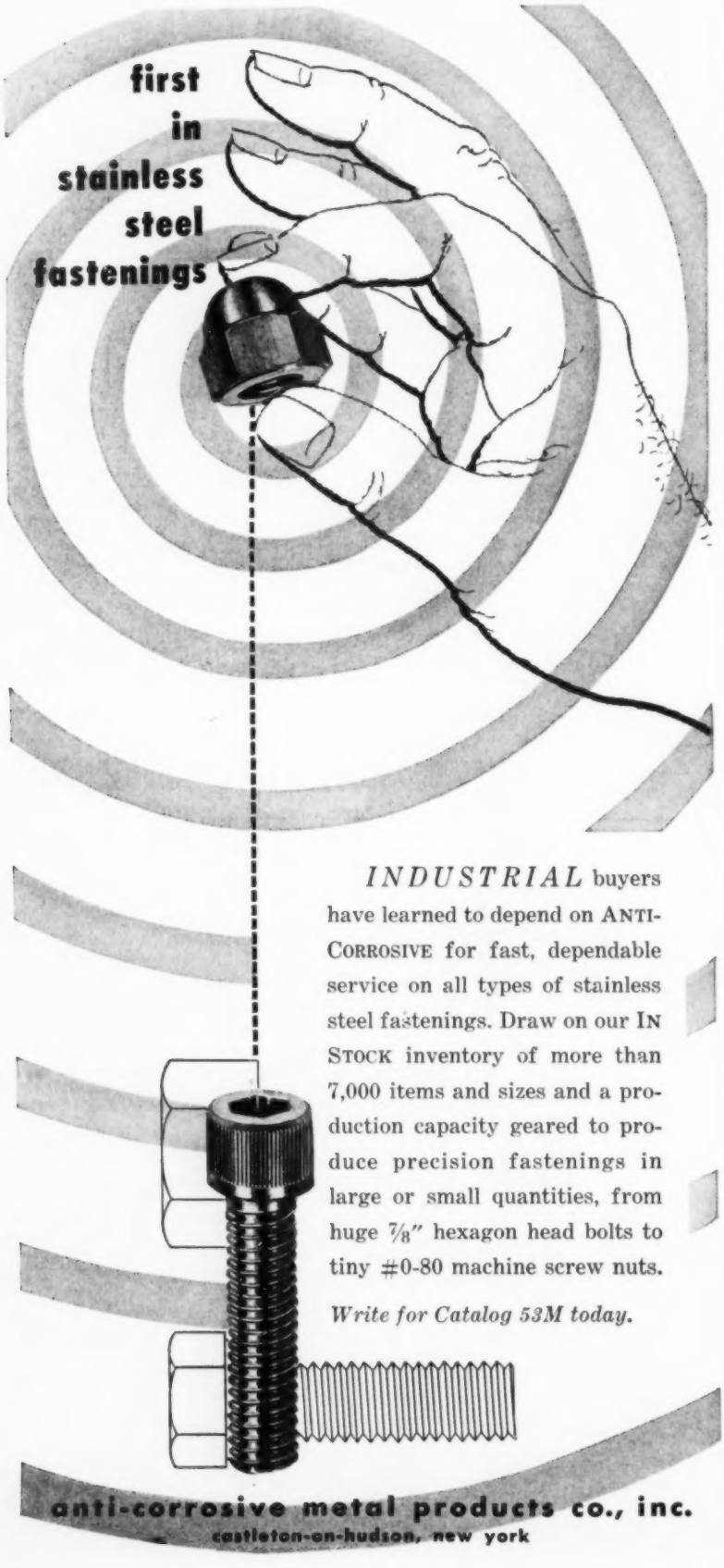

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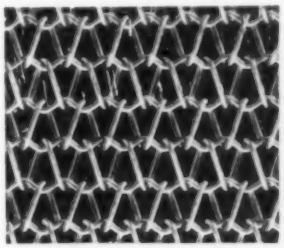
Here's why leading manufacturers specify CAMBRIDGE Wire Mesh Conveyor Belts . . .

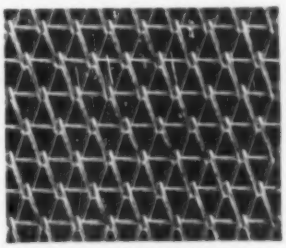
ACCURATE CONSTRUCTION—every step of the construction of your belt is carefully controlled so that the finished belt meets specifications for size, mesh count and mesh openings. Even the welds at the edge of the belt are specially inspected to make sure you get maximum protection at this most vulnerable part of the belt.

RANGE OF SPECIFICATIONS—regardless of the type of product to be handled by the equipment you design, there's a Cambridge wire belt specification to meet your needs . . . close meshes for small parts or flat bottom containers, open meshes for larger or heavier parts. Even processing through heat, cold or corrosive conditions is a snap when the proper metal or alloy is chosen for fabricating your Cambridge wire mesh conveyor belt.

EXPERIENCED ENGINEERING SERVICE — the combination of trained engineers both in the Cambridge plant and on our sales staff is your assurance that the belt recommended for you is the right belt. Cambridge engineers can work with you in any phase of conveyor belt usage . . . conveyor design, plant layout, equipment specifications, etc.

P. S. IF YOU HAVEN'T CONSIDERED WIRE MESH BELTS you'll do well to find out how they cut costs and speed production by combining movement with processing of foods, chemicals, metal or ceramic products. For information write direct or call in your Cambridge Field Engineer. Look under "Belting-Mechanical" in your classified telephone directory for the Cambridge man nearest you.





Typical Cambridge belt weaves, Balanced and Rod-Reinforced are widely used for many processes which can be combined with movement, as well as for ordinary handling. Other weaves are also available.

NEW, WIRE BELT MANUAL, FREE

Gives data on design, installations and construction. Write for your copy now.

The Cambridge Wire Cloth Company

WIRE CLOTH | METAL CONVEYOR BELTS | SPECIAL METAL FABRICATIONS

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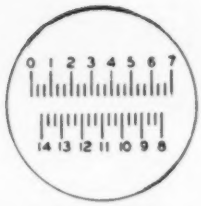

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...IN ANY DESIGN

Now Available in Quantity from

EXPANDED FACILITIES OF W. & L. E. GURLEY

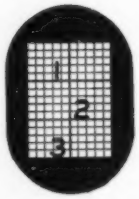
Are you limiting your range and variety of reticle patterns to suit an available reticle-manufacturing process? You needn't at Gurley; here you can obtain the procedure best suited to your particular design and production requirements.

This century-old manufacturer of scientific instruments now offers for the first time on a contract-manufacturing basis its highly-developed photographic, microscopic ruling and etching facilities for producing *glass reticles* for all types of telescopes and optical measuring instruments.

Added to Gurley's extensive reticle-design and manufacturing facilities is an advanced photographic process developed during the war, to meet the low-tolerance specifications for reticles in gunsights and bombsights.

At Gurley you have the flexibility of several manufacturing processes and specially designed equipment to draw on—plus Gurley's long experience in optics, lens grinding and scientific instrument manufacture. Photograph and etch methods, direct ruling on a dividing engine or pantograph, as well as appropriate combinations of several of these methods, broaden the range of reticle pattern designs and assure their economical production in small or large runs.

Consult Gurley on your particular reticle needs —whatever the design or quantity.



W. & L. E. GURLEY, 301 Gurley Bldg., Troy, N. Y.

GURLEY

Optical Reticles, Engineering and Surveying Instruments, Hydraulic Engineering Instruments, Standard Precision Weights and Measures, Paper and Textile Testing Instruments, Aeronautical Navigating Instruments, Meteorological Instruments.

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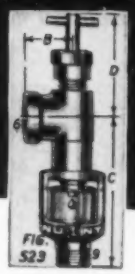
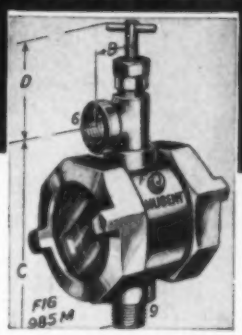
See...Don't Guess

Install NUGENT Sight Feed Valves for LUBRICATION CONTROL



13 models designed for working pressures to 125 psi. Sizes to ¾ inch.



9 models for larger machinery. "Swivel and lock" type for sight chamber adjustment to most convenient view position.

Medium size needle type with steel valve stem. 9 models. Sizes to ¼ inch.

DESIGN your oil line with a Nugent Sight Feed Valve and the user will be able to tell at a glance whether or not vital parts are receiving proper lubrication. Oil flow through the valve is controllable from 2 drops per min. to 21 U.S. gals. per hour depending upon oil viscosity and valve model. All are vented to prevent air binding. Glasses and screens are removable for cleaning without interrupting oil flow.

SIGHT FLOW INDICATORS

ANOTHER NUGENT instrument for solving lubrication problems is the Sight Flow Indicator. Installed in a machinery oil system, this device sounds an alarm when oil is not getting to bearings. When oil is not flowing properly, Indicator "B" (See Fig. 1001-F) closes making contact with terminals "J". This sounds the alarm making it possible to locate trouble quickly, protect valuable machinery and save on costly down time.

Sight Flow Indicator available with tapped or flanged connections. Removable windows. Can be installed right or left hand or vertically.

For trouble free lubrication systems, write for descriptive bulletin on the Nugent Sight Feed Valve, Sight Flow Indicator and other Lubrication Specialties.

Wm. W. Nugent & Co., Inc.
441 N. Hermitage Ave. CHICAGO 22, ILLINOIS

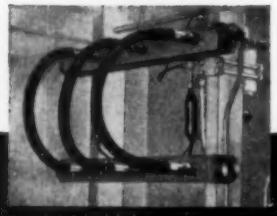
OIL FILTERS, OILING AND FILTERING SYSTEMS, TELESCOPIC OILERS, OILING DEVICES, SIGHT FEED VALVES, FLOW INDICATORS

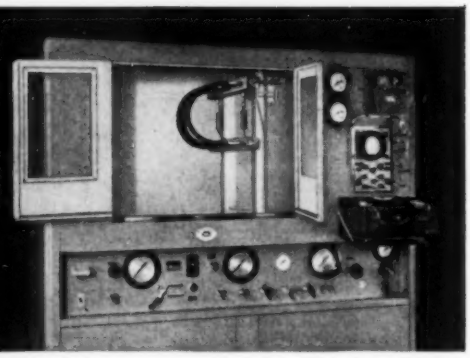
Established 1897

Representatives in Boston • Cincinnati • Detroit • Houston • San Jose, Calif. • Los Angeles • Minneapolis • New Orleans • New York • Philadelphia • Portland, Ore. • San Francisco • Seattle • St. Louis • Tulsa • Representatives in Canada: Montreal • Toronto • Vancouver

Subjected to toughest hose test . . . yet

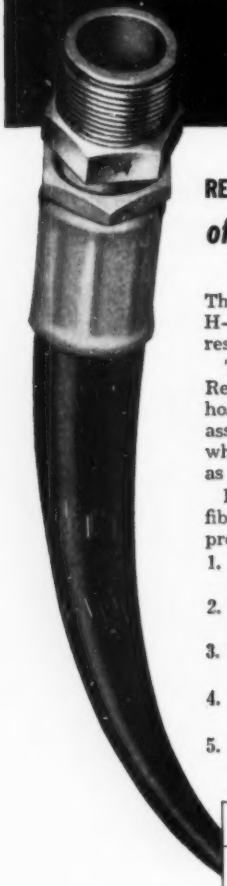
still OK after 147,000 shock loads





TEST CONDITIONS ON IMPULSE TESTER

(A) 14 impulses per minute. (B) Min. pressure rise: 34,000 psi/sec. (C) Max. pressure rise: 50,000 psi/sec. (D) Peak impulse pressure: 125% of working pressure.



RESISTOFLEX INDUSTRIAL HYDRAULIC HOSE ASSEMBLIES

offer high burst strength, too!

The hydraulic impulse test, as outlined in military spec. MIL-H-5511, shows how well these *industrial* hose assemblies resist fatigue.

To this 100,000 cycle test, while plenty tough by itself, Resistoflex added a 160°F requirement—making it the toughest hose test yet. Despite this, Resistoflex medium-high pressure assemblies were still going strong after 147,000 cycles . . . at which time attempts to fatigue the assemblies were abandoned as futile.

Built with tough compar tube and high strength synthetic fibre-braid reinforcement, Resistoflex hose assemblies also provide five other features for *more hose value per dollar:*

1. High burst strengths – stay high even as working age increases.
2. High pull strength – more than 3500 lbs. for ½" hose. Couplings won't pull out even under this tension!
3. High impact strength – hose returns to original cross section after crushing load.
4. Full flow fittings – fitting bore equals hose I.D. – Hose constriction at crimp is less than 5%.
5. No gumming or clogging of hydraulic circuit – Compar tube inert to all hydraulic oils.

I.D. (inches)	Working Pressure (psi)	Min. Burst Pressure (psi)	Assembly Tensile Strength (lbs.)
¼	2300	9200	900
⅜	2050	8200	2500
½	1800	7200	3500

Write for Data Sheet MH-16.

RESISTOFLEX

CORPORATION

Belleville 9, New Jersey

SPECIALLY ENGINEERED FLEXIBLE RESISTANT PRODUCTS FOR INDUSTRY

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■

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S.S.WHITE FLEXIBLE SHAFTS

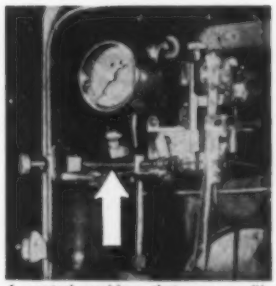
...the time-and-money-saving answer to drive and control problems involving alignment

Shown here are a few of the many ways in which designers are using S.S.White flexible shafts to lick alignment problems – on remote control and power drive applications.

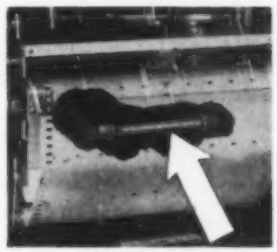
In cases like these, the shafts **completely eliminate the need for accurate alignment,** making possible major design improvements and **substantial reductions in manufacturing and assembly costs.** The non-rigid construction of the shafts automatically compensates for misalignment – absorbs shock and vibration – and simplifies assembly and machining operations.

Built up of tension-wound layers of special grades of wire, S.S.White flexible shafts possess amazing strength and flexibility. In performance they operate as easily, as smoothly and as dependably as a direct connection.

Take advantage of the cooperation of S.S.White engineers in applying flexible shafts to your needs – there's no obligation.



A control problem that was readily solved by a short length of S.S.White remote control flexible shafting.



Using an S.S.White power drive flexible shaft to couple a motor to the operating mechanism solved this alignment problem.

WRITE FOR THE FLEXIBLE SHAFT HANDBOOK

It contains 256 pages of information on flexible shaft selection and application. Copy sent free if you ask for it on your business letterhead.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. D, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

"Savings: $50,000.00 A YEAR... ...WITH OUR Trabon AUTOMATIC LUBRICATION SYSTEM"

Photo Courtesy Cans, Inc.

CANS, INCORPORATED
5217 WEST FORTY-SEVENTH PLACE • PHONE FRONTIER 6 2700
CHICAGO 32, ILL.
August 5, 1952

Dudley C. Jackson, Inc.,
6752 Stony Island Avenue
Chicago 49, Illinois

Subject - Trabon Automatic Lubrication Systems

Gentlemen:

Through the installation of the Trabon automatic lubrication system on our air testers on the dog food can assembly line, we cut down on lubricating costs 95% and also reduced our production downtime for lubricating purposes from three hours per day to approximately 15 minutes per day. This machine has 249 grease fittings which formerly required attention after every 8 hour shift. The lubrication by hand required the services of one man for one hour after each shift on an overtime basis.

In addition, other desirable savings have been realized through the assurance of proper lubrication. It has brought about an 86% savings in grease consumption. Excess grease formerly accumulated on machine parts and eventually worked its way on to the cans, resulting in a high rate of rejected cans which had to be wiped clean by hand. The previous inefficient hand method of lubricating resulted in the neglect of some vital parts causing approximately 100 hours of downtime per year and approximately $1200.00 labor and material cost to replace the parts. In terms of production, this amounts to over 2,000,000 cans or a loss in sales of well over $50,000.00 annually. At present, repairs are scheduled and no production time is lost. It is estimated that our lubricating costs alone are reduced to $100.00 per year, a reduction of over 90% which is enough to pay for the entire cost of the Trabon automitic lubricating system. The biggest savings, of course, is in the elimination of downtime which, as every manufactuer knows, is a very costly factor.

This automatic lubricating system has fulfilled its purpose beyond all of our expectations.

Very truly yours,
CANS, INCORPORATED
R. S. Solinsky
President
A. M. Toft
Vice President

RSS:if

Specialists in the Manufacture of Plain and Decorated Metal Containers and Housewares Items.

CANS

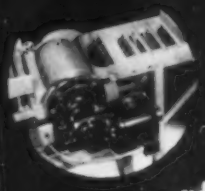
this has a BEARING on the subject

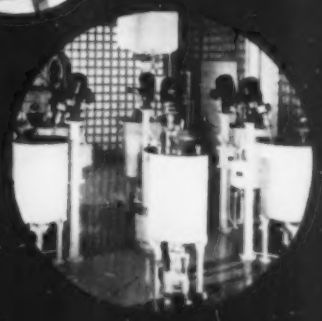
For more than 22 years, Trabon has been saving thousands of dollars for a wide variety of metal-working and metal producing plants, by its patented centralized lubrication systems for either oil or grease.

Get your bearings on a Trabon System. Bulletin 529 will be sent promptly on request.

Trabon Lubrication Fits Any Bearing Situation

Trabon ENGINEERING CORPORATION
1814 E. 40th STREET • CLEVELAND 3, OHIO
Oil and Grease Systems





On big jobs or little ones it pays to take advantage of Master's unusual ability to supply the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

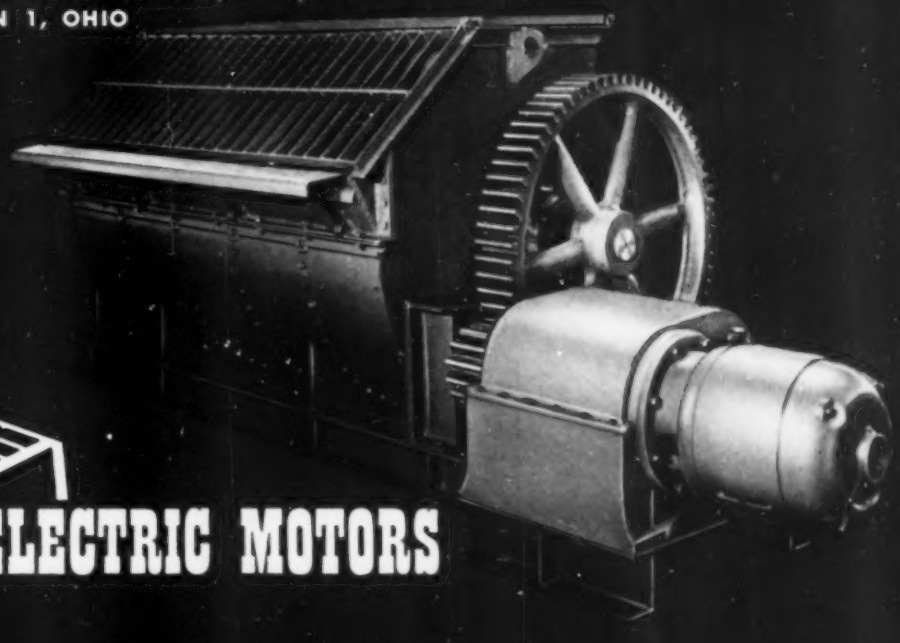
Don't put up with make-shift assemblies when you too may be enjoying these advantages. Master Motors, available in thousands and thousands of types and ratings (up to 200 HP) give you a selection you can get nowhere else.

Open, enclosed, splash proof, fan-cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with electric brakes . . . with mechanical variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO

BIG ones



MASTER
ELECTRIC MOTORS

McCormick cotton picker uses GRAMIX® bearings

As one of International Harvester's big high-drum type McCormick Cotton Pickers moves down a row of cotton, 600 barbed picking fingers, rotating at speeds up to 2700 r.p.m.'s, pluck the cotton from the open bolls. And bronze GRAMIX bearings, on the barbed fingers, help make the successful operation of this ingenious picking device possible. This is typical of the way GRAMIX parts have helped improve many products and made the development of many other products possible. GRAMIX is produced from metal powders, compacted under pressures up to 70,000 psi and sintered at high temperatures to form strong, tough alloyed metal parts that will usually outperform and outlast parts produced by old fashioned machining methods. GRAMIX bearings and other specialty parts can be die-pressed into fairly intricate shapes with tolerances as close as .0005". They require little or no machining, thus saving man-hours of production time and greatly reducing scrap loss and waste. Because of their porous structure, GRAMIX parts require less metal and they can be oil-impregnated during manufacture to insure a constant oil film at the bearing surface.

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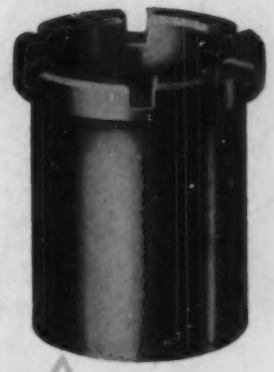
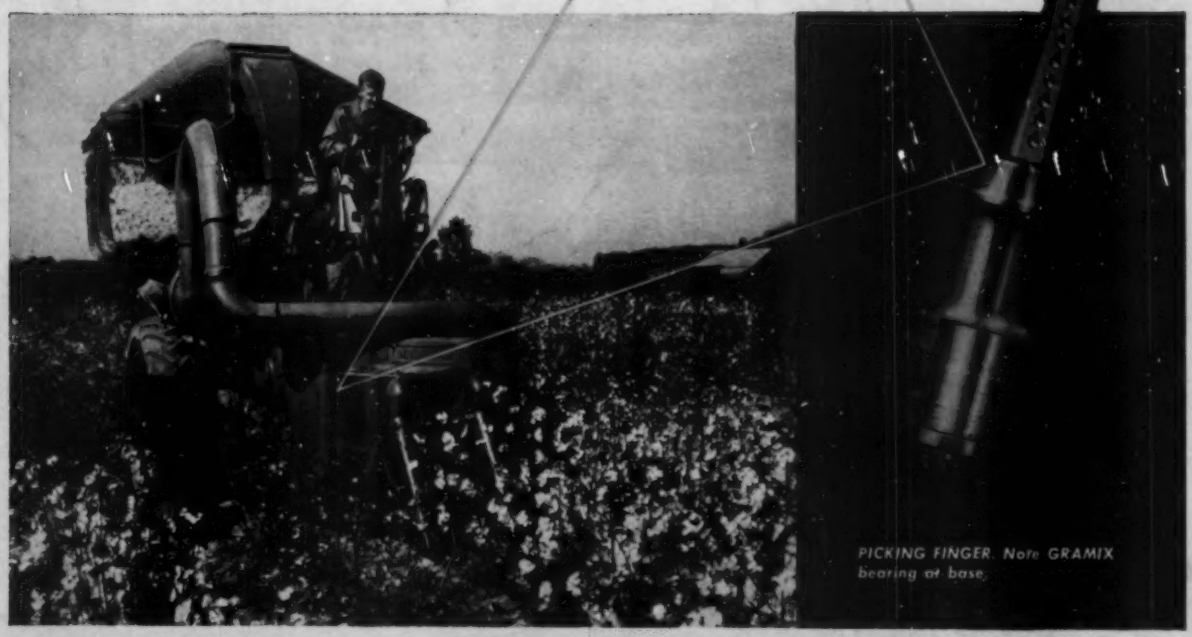


GRAMIX bearings like this help the barbed fingers of the picking unit operate so efficiently in the amazing McCormick Cotton Picker.

95



PICKING FINGER. Note GRAMIX bearing at base.

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